

JAPANESE JOURNAL OF BOTANY

Volume VI

Publication Committee

S. IKENO (*Chairman*)

K. KÔRIBA

K. SHIBATA

---



NATIONAL RESEARCH COUNCIL OF JAPAN

學術研究會議編纂

日本植物學輯報

原著及抄錄

昭和八年 第六卷

JAPANESE  
JOURNAL OF BOTANY

Transactions and Abstracts

Volume VI  
(1932-33)

TOKYO  
1933



# CONTENTS

## TRANSACTIONS

	Page
ASAI, T.: Untersuchungen über die Bedeutung des Mannits im Stoffwechsel einiger höheren Pflanzen. Teil I (10 Textabb.) .	63
FUKUDA, Y.: Hygronastic curling and uncurling movement of the leaves of <i>Rhododendron micranthum</i> TURCZ. with respect to temperature and resistance to cold (14 text-figs.) . . .	191
——: Cyto-genetic studies on the wild and cultivated Manchurian soy beans (Pls. XXI-XXII and 7 text-figs.) . . .	489
FUKUSHI, T.: On some properties of the tobacco mosaic virus .	381
HIRATSUKA, N.: Inoculation experiments with some heteroecious species of the Melampsoraceae in Japan . . . . .	1
——: Studies on <i>Uromyces Fabae</i> and its related species (Pls. XVI-XVII) . . . . .	329
HIURA, M. and KAWADA, S.: On the overwintering of <i>Peronosplasmopara cubensis</i> (B. et C.) CLINTON (Pl. XXIII) . . .	507
KAGAWA, F. and NAKAJIMA, G.: Genetical and cytological studies on species hybrids in <i>Quamoclit</i> (Pls. XII-XV and 14 text-figs.) . . . . .	315
KIHARA, H.: Weitere Untersuchungen über die pentaploiden <i>Triticum</i> -Bastarde II (2 Textabb.) . . . . .	35
KIHARA, H. and NISHIYAMA, I.: Different compatibility in reciprocal crosses of <i>Avena</i> , with special reference to tetraploid hybrids between hexaploid and diploid species (NISHIYAMA, I.: The genetics and cytology of certain cereals III) (Pls. X-XI and 51 text-figs.) . . . . .	245
KIHARA, H., WAKAKUWA, Sh. und YAMAMOTO, Y.: Weitere Untersuchungen über die pentaploiden <i>Triticum</i> -Bastarde III (2 Textabb.) . . . . .	411
LILIENFELD, F.A.: Karyologische und genetische Studien an <i>Fragaria</i> . Ein tetraploider fertiler Bastard zwischen <i>F. nipponica</i> (n = 7) und <i>F. elatior</i> (n = 21) (37 Textabb.) . .	425
MASAMUNE, G.: Phytogeographical position of Japan concerning indigenous genera of vascular cryptogamic plants . . . .	307



	Page
MATSUMOTO, K.: Effect of seed-formation on the rate of respiration of the Japanese persimmon or kaki ( <i>Diospyros Kaki</i> L. fl.) (1 text-fig.) . . . . .	125
MORINAGA, T.: Interspecific hybridization in <i>Brassica</i> V. The cytology of F <sub>1</sub> hybrid of <i>B. carinata</i> and <i>B. alboglabra</i> (Pl. XX and 14 text-figs.) . . . . .	467
NAMIKAWA, I., SISA, M. and ASAI, K.: On the flower types of <i>Diospyros Kaki</i> , L. fl. (23 text-figs.) . . . . .	139
NOGUCHI, Y.: Studies on the species crosses of Japanese <i>Rhododendron</i> I. On the crossability between various species and the cotyledon color of F <sub>1</sub> seedlings (Pls. I-II) . . . . .	103
OGURA, Y.: On the structure of "hobashira-ishi," a famous silicified trunk at Najima near Fukuoka City (Pl. III and 4 text-figs.) . . . . .	173
——: On the structure of a silicified wood found near "hobashira-ishi" at Najima near Fukuoka City (Pl. IV and 4 text-figs.) . . . . .	183
OHARA, K.: Mikrochemische Untersuchungen an über 1,800 Jahre lange aufbewahrten Holz—ein Beitrag zur Kohlenentstehungstheorie (Taf. XVIII-XIX und 5 Textfig.) . . . . .	393
TOGASHI, K. and UCHIMURA, K.: A contribution to the knowledge of parasitism of <i>Valsa Paulowniae</i> , in relation to temperature (4 text-figs.) . . . . .	477
U, N.: On the reappearance of haploid in the Japanese morning glory (Pls. V-IX and 9 text-figs.) . . . . .	225
YAMASAKI, M.: Identification of the sexes in dioecious plants by testing the resistance to the toxic action of chlorate (4 text-figs.) . . . . .	467

## ABSTRACTS

(Papers of which the title only is cited are marked with an \*)

	Page Entry
ABE, T.: On the effect of sunlight on the infection of the rice plant by <i>Piricularia Oryzae</i> . . . . .	(27) 77
——: On the relation of air humidity to germination and the effect of low temperature on the vitality of urediniospores of some species of cereal rusts . . . . .	(95) 334



	Page	Entry
ABE, T. and OKAMURA, E.: On the effect of copper sulphate upon the susceptibility of the rice plant to the blast disease . . . . .	(27)	78
ADATI, S.: Untersuchungen über die Chromosomenzahlen bei den asiatischen <i>Pyrus</i> arten . . . . .	(95)	335
AKIYAMA, S.: Diagnosis specierum novarum caricum . . . . .	(1)	1
——: Conspectus caricum japonicarum. A general view of Japanese carices, including those from Saghalien, the Kuriles, Hokkaido, Honshiu, Shikoku, Kiushiu and the Riukius with special reference to utricles in female flowers . . . . .	(63)	214
——: On the systematic anatomy of the leaves of some Japanese carices I . . . . .	(95)	336
ARAKI, S.: Karyologische Untersuchungen über einen Arthbastard zwischen <i>Potentilla chinensis</i> (haploid 1n) und <i>P. nipponica</i> (haploid 2n). . . . .	(27)	79
*ASAI, T.: Untersuchungen über die Bedeutung des Mannits im Stoffwechsel einiger höheren Pflanzen Teil I . . . . .	(27)	80
CHIZAKI, Y.: Chromosome studies of $F_1$ <i>Aegilops speltoides</i> × <i>Triticum monococcum</i> . . . . .	(63)	215
EGAMI, T.: Über eine neue Krankheit von <i>Aesculus turbinata</i> . . . . .	(95)	337
EMOTO, Y.: Über einige Myxomyceten . . . . .	(1)	2
——: Eine neue Art von Myxomyceten . . . . .	(28)	81
——: Über die Chemotaxis der Myxomyceten-Plasmodien . . . . .	(63)	216
——: Über zwei noch nicht in Japan bekannte Myxomyceten . . . . .	(64)	217
——: Verbreitung der schwefeloxydierenden Bakterien in den Thermen Japans . . . . .	(96)	338
——: Myxomyceten aus Mexiko . . . . .	(96)	339
——: Myxomyceten der Südmandschurei, 2. Mitteilung . . . . .	(96)	340
——: Die Mikroorganismen der Thermen. Eine historische Uebersicht über die Erforschung der Thermalorganismen . . . . .	(96)	341
——: Studien über die Myxomyceten in Japan . . . . .	(96)	342
ENDÔ, S.: On <i>Cercospora circumscissa</i> SACC., pathogenic on the leaves of <i>Prunus Mume</i> S. et Z. . . . .	(28)	82
——: Studies on the sclerotium disease of the rice plant. IV. On the morphology of certain important fungi causing sclerotium diseases of the rice plant . . . . .	(28)	83
——: Studies on the sclerotium disease of the rice plant. V. Ability of overwintering of certain important fungi causing sclerotium disease of the rice plant and their resistance to dry condition . . . . .	(28)	84
——: The host plants of <i>Hypochnus centrifugus</i> (LÉV.) TUL. ever recorded in Japan . . . . .	(64)	218

ENDÔ, S.: Studies on the antagonism of microorganisms II. Growth of <i>Hypochnus Sasakii</i> SHIRAI as influenced by the antagonistic action of other microorganisms.—III. Pathogenicity of <i>Hypochnus centrifugus</i> TUL. and <i>Hypochnus Sasakii</i> SHIRAI in the presence of other microorganisms . . . . .	(64)	219, 220
——: Influence of carbohydrates and organic nitrogen compounds on the antagonistic action of microorganisms . . . . .	(64)	221
FUJITA, T.: Über die Beziehung zwischen dem Eiweissgehalt der Blätter und dem Grad der Sonnenbeleuchtung . . . . .	(28)	85
FUKAKI, S.: Untersuchungen über die Bestockung der Reispflanzen ( <i>Oryza sativa</i> ). II. Einfluss der Wasser- und Lufttemperatur und der Luftfeuchtigkeit auf die Bestockung . . . . .	(28)	86
——: On the effect of plant nutrients and sunlight on the formation of first "anlage" of the tillers in rice plant . . . . .	(29)	87
FUKANO, H.: Cytological studies in <i>Hypochnus Sasakii</i> SHIRAI, causing a sclerotial disease of rice plant . . . . .	(65)	222
*FUKUDA, Y.: Hygronastic curling and uncurling movement of the leaves of <i>Rhododendron micranthus</i> TURCZ. with respect to temperature and resistance to cold . . . . .	(65)	223
FUKUSHI, T.: On the intracellular bodies associated with the dwarf disease of rice plant . . . . .	(65)	224
——: A contribution to our knowledge of virus disease of plants in Japan . . . . .	(65)	225
*——: On some properties of the tobacco mosaic virus . . . . .	(96)	343
HAGIWARA, T. Genetico-physiological studies in the seed-colour of Japanese morning glory . . . . .	(1)	3
——: The genetics of flower colour in <i>Pharbitis Nil</i> . . . . .	(1)	4
——: On the genetico-physiological studies of the colour-development of flowers in <i>Pharbitis Nil</i> . . . . .	(29)	88
HAMA, T.: Studien über eine neue <i>Rhodospirillum</i> aus Yumoto bei Nikko . . . . .	(96)	344
——: Nine species belonging to the order Thiobacteriales BUCHANAN found in Hiroshima . . . . .	(97)	345
HAMADA, H.: Über die Beeinflussung des Wachstums des Mesokotyls und der Koleoptile von <i>Avena</i> -Keimlingen durch das Licht. . . . .	(2)	5
HANDA, T.: Über die sukzessiven Holzbastränge von <i>Pueraria triloba</i> , MAKINO und <i>Wistaria floribunda</i> , DC. . . . .	(29)	89
HARA, S.: Delay of the heading time in rice by cutting . . . . .	(30)	90
HASEGAWA, N.: Comparison of chromosome types in <i>Disporum</i> . . . . .	(65)	226
HATAE, N.: A new <i>Caulopteris</i> from the Wu-hu-tsui coal-field of South Manchuria, <i>Caulopteris manchuriensis</i> sp. nov. . . . .	(2)	6
HAYASI, S.: Relation entre l'âge des graines et le sexe chez l'épinard . . . . .	(30)	91



	Page	Entry
HAYATA, B.: La systématique des plantes. Tome I. Les gymnospermes	(97)	346
——: What is the classification?	(98)	347
HEMMI, T.: Notes on some Japanese fungi	(30)	92
——: Studies on some wood-destroying fungi attacking conifers in Japan	(30)	93
—— and ABE, T.: On the relation of temperature and period of constant wetting to the infection of the rice plants by <i>Piricularia Oryzae</i> .	(31)	94
—— ——— ENDÔ, S.: Studies on sclerotium diseases of the rice plant III. Some experiments on the sclerotial formation and the pathogenicity of certain fungi causing sclerotium diseases of the rice plant	(31)	95
—— ——— KURATA, S.: Pathological studies on <i>Polyporus betulinus</i> (BULL.) FR.	(31)	96
—— ——— ———: Notes on three disease of Azaleas	(31)	97
—— ——— ———: Beiträge zur Kenntnis der japanischen Pilze. I	(31)	98
—— ——— ———: Miscellaneous notes on Japanese fungi. I	(99)	348
—— ——— NOJIMA, T.: <i>Polyporus Mikadoi</i> LLOYD	(32)	99
—— ——— ———: On the relation of temperature and period of constant wetting to the infection of rice blast by <i>Ophiobolus Miyabeanus</i> .	(32)	100
——, SETO, F. and IKEYA, J.: Studies on the "bakanae" disease of the rice plants III. On the infection of rice by <i>Lisea Fujikuroi</i> SAWADA and <i>Gibberella Saubinetii</i> (MONT.) SACC	(32)	101
—— and SUZUKI, H.: On the relation of soil moisture to the development of the <i>Helminthosporium</i> disease of rice seedlings	(32)	102
HINO, I.: The behavior of <i>Citrus</i> canker organisms in soil and water	(66)	227
——: Genus <i>Miyoshiella</i> to be included in genus <i>Chaetosphaeria</i>	(66)	228
HIRAMATSU, K.: On the daily progress of carbon assimilation in the shadow under natural conditions	(32)	103
HIRATA, E. and TAKENOUCHI, H.: Studies on the morphological and physiological characters of <i>Sclerospora graminicola</i> on <i>Setaria italica</i> .	(66)	229
HIRATA, K.: Heredity of intersexuality in hemp	(2)	7
—— and YAMAMOTO, K.: On the occurrence of female intersexual plants in <i>Spinacia</i> and <i>Melandrium</i>	(2)	8
*HIRATSUKA, N.: Inoculation experiments with some heteroecious species of the Melampsoraceae in Japan	(33)	104
——: Additional notes on the Melampsoraceae of Hokkaido II.	(99)	349
——: On species of the Melampsoraceae collected in Nikko and its vicinity	(99)	350
*——: Studies on <i>Uromyces Fabae</i> and its allied species	(99)	351
—— and HASHIOKA, Y.: Uredinales collected in Formosa I.	(99)	352
HIRAYAMA, S.: On the influence of osmotic pressure of culture media on the mycelial growth of <i>Piricularia Oryzae</i>	(33)	105

	Page	Entry
HIRAYAMA, S.: On the effect of soil moisture to the cell sap concentration of rice seedlings . . . . .	(33)	106
HONDA, M.: Nuntia ad floram japonicae XII-XXI . (3), (33), (67), (99) 9, 107, 230, 353		
——: On a new species of <i>Didymoplexis</i> . . . . .	(33)	108
HORIKAWA, Y.: Studies on the Hepaticae of Japan V-VIII. (3), (33), (100) 10, 110, 354		
——: Die epiphyllen Lebermoose von Japan . . . . .	(33)	109
HOSOKAWA, T.: Notulae leguminosarum ex Asiae-orientalis II-III . . . . .	(67)	231
IKATA, S.: Supplement to "Studies on leaf-fall disease of <i>Diospyros Kaki</i> " I . . . . .	(34)	111
——: Studies on "Kurobosi" (black star)- disease of <i>Diospyros Kaki</i> . . . . .	(34)	112
—— and al: On the mode of penetration of a <i>Peronospora</i> species into a host . . . . .	(34)	113
—— — HITOSHI, T.: A new blight disease of the grape-vine . . . . .	(35)	114
IKENO, S.: A preliminary report of a new septorial leaf-spot disease of the lily leaves . . . . .	(35)	115
IMAI, S.: On the Clavariaceae of Japan III. The species of <i>Clavaria</i> found in Hokkaido and Southern Saghalien . . . . .	(3)	11
——: Contribution to the knowledge of the classification of Helvel- laceae . . . . .	(35)	116
——: Studies on the Hypocreaceae of Japan. I. <i>Podostroma</i> . . . . .	(67)	232
——: On <i>Stropharia caerulescens</i> , a new species of poisonous toadstool. . . . .	(67)	233
——: On the taxonomy of nameko fungus in Japan . . . . .	(100)	355
——: Studies on the Agaricaceae of Japan. I. Volvate agarics in Hokkaido . . . . .	(100)	356
IMAMURA, S.: Über die Dorsiventralität der unifazialen Blätter von <i>Iris japonica</i> THUNB., und ihre Beeinflussbarkeit durch die Schwerkraft . . . . .	(3)	12
IMAMURA, Y. and HURUYA, M.: On the concentration of cell-sap in mul- berry leaves. . . . .	(67)	234
INARIYAMA, S.: Cytological studies in the genus <i>Lycoris</i> . I. Conjugation of chromosomes in meiosis of <i>Lycoris albiflora</i> , KOIDZ . . . . .	(67)	235
INOH, S.: Embryological studies on <i>Sargassum</i> and <i>Cystophyllum</i> . . . . .	(35)	117
——: Keimentwicklung von <i>Pelvetia Wrightii</i> YENDO . . . . .	(100)	357
INOUE, C.: Somatic mitosis in <i>Hordeum sativum</i> . . . . .	(4)	13
——: Meiosis in barley . . . . .	(68)	236
ISHII, T.: Über die Struktur der Chromosomen . . . . .	(4)	14
ISHIJIMA, W.: On two new species of Corallineae from the Tertiary of Japan . . . . .	(36)	118
ITO, S.: Primary outbreak of the important diseases of the rice plant and common treatment for their control . . . . .	(100)	358
—— and NAGAI, M.: On the rot-disease of the seeds and seedlings of rice-plant caused by some aquatic fungi . . . . .	(36)	119



	Page	Entry
ITO, S. and TERUI, M.: On the influence of oryzanin upon the development of some parasitic fungi . . . . .	( 36 )	120
ITÔ, H.: On the distribution of ferns in the southern part of Japan proper . . . . .	( 4 )	15
JIMBO, T.: Pollen-analytical studies of peat formed on volcanic ash . . . . .	( 36 )	121
——: On the daily fluctuation of the osmotic value in plants II . . . . .	( 68 )	237
*KAGAWA, F. and NAKAJIMA, G.: Genetical and cytological studies on species hybrids in <i>Quamoclit</i> . . . . .	(101)	359
KAMBAYASHI, T.: Eine botanische Untersuchung der <i>Microspira furfur</i> ROBIN . . . . .	( 36 )	122
——: Botanische Untersuchungen über japanische Fadenpilze, die auf der Menschenhaut parasitieren II. Mitteilung. <i>Microsporon japonicum</i> . . . . .	( 68 )	238
KANDA, T.: The inheritance of seed-coat colour in the water-melon . . . . .	( 5 )	16
——: Influence of the difference of the pollination mode on the fruits, seeds, and the next generation in a pure line of water-melon . . . . .	( 68 )	239
KANEHIRA, R.: An enumeration of the woody plants recorded from Micronesia, Japanese mandate (in 1929 and 1930) . . . . .	( 5 )	17
——: New or noteworthy trees from Micronesia (I, II, III) . . . . .	( 69 )	240
KANNA, B.: On the striped flowers of <i>Mirabilis Jalapa</i> . . . . .	(101)	360
KARASAWA, K.: On triploid tea . . . . .	( 69 )	241
——: Karyological studies on some flowers of <i>Crocus</i> . . . . .	( 69 )	242
KATAYAMA, Y.: Variation in the number of bivalent chromosomes in the $F_1$ hybrids between <i>Triticum durum</i> and <i>Aegilops ventricosa</i> . . . . .	( 5 )	18
——: Über den Ansatz und die Keimungsfähigkeit der Körner in reziproken intra- und intergenerischen Bestäubungsversuche im Weizen <i>Aegilops</i> Kreise und die Sterilität der $F_1$ -Pflanzen . . . . .	( 5 )	19
KATOO, H.: Spodograms of the leaves of barley . . . . .	( 69 )	243
KATÔ, K.: Viscosity changes in the cytoplasm during mitosis as indicated by Brownian movement . . . . .	(101)	361
*KIHARA, H.: Weitere Untersuchungen über die pentaploiden <i>Triticum</i> -Bastarde II . . . . .	( 37 )	123
——: Genetische Studien an gestreiften Sippen von <i>Celosia cristata</i> . I. . . . .	( 37 )	124
——: Chromosom-Aberranten bei <i>Pharbitis Nit</i> . . . . .	( 70 )	244
—— und KATAYAMA, Y.: Genomanalyse bei <i>Triticum</i> und <i>Aegilops</i> . H. KIHARA. III. Zur Entstehung eines neuen konstanten oktoploiden <i>Aegilotriticum</i> . . . . .	( 6 )	20
——: Über das Vorkommen von haploiden Pflanzen bei <i>Triticum monococcum</i> . . . . .	( 70 )	245
*—— and NISHIYAMA, I.: Different compatibility in reciprocal crosses in <i>Avena</i> , with special reference to tetraploid hybrids between hexaploid and diploid species (NISHIYAMA, The genetics and cytology of certain cereals III) . . . . .	( 70 )	246

	Page	Entry
*KIHARA, H., WAKAKUWA, SH. und YAMAMOTO, Y.: Weitere Untersuchungen über die pentaploiden <i>Triticum</i> -Bastarde III . . . . .	(101)	362
—— und YAMAMOTO, Y.: Karyomorphologische Untersuchungen an <i>Rumex acetosa</i> L. und <i>Rumex montana</i> DESF. . . . .	( 7 )	21
KIKUCHI, M.: On the hydrogen-ion concentration of the solution in water-culture of flax-plant . . . . .	(101)	363
KIMURA, S.: Über die Kätzchen von <i>Chosenia</i> . . . . .	(101)	364
KISHINAMI, Y.: Über die alpinen Pflanzen der Tôrôhôkette in Nordkorea. . . . .	( 37 )	125
KISITANI, T.: Zur Morphologie und Biologie einer Leuchtbakterienart ( <i>Pseudomonas phosphorescens</i> KISITANI) . . . . .	(102)	365
KITAMURA, S.: Compositae novae japonicae II-V . . . . .	(38), (70), (102)	126, 247, 366
——: An enumeration of Compositae of Formosa (I) . . . . .	( 70 )	248
KOIDZUMI, G.: Contributiones ad cognitionem florum Asiae orientalis . . . . .	(38), (70)	127, 249
——: Plantae japonicae rarissime vel dubiae . . . . .	( 71 )	250
——: The classification synopsis of the Mastigophora . . . . .	(102)	367
KOIDZUMI, H.: <i>Taraxacum</i> novum orientali-asiaticum I. . . . .	(103)	368
KOJIMA, H.: Division, growth and differentiation of cells in the root of <i>Vicia Faba</i> artificially inhibited from further elongation . . . . .	( 7 )	22
KOMURO-Hideo: Über ein neues Fixierungsmittel . . . . .	( 71 )	251
KONDO, T.: Zur Kenntnis des N-Gehaltes des Mykorrhizaknöllchens von <i>Podocarpus macrophylla</i> D. DON . . . . .	( 8 )	23
KONDO, Y.: Studien über die Erkennung der Drogen auf Grund des Aschenbildes (II. Mitteilung). Aschenbilder wichtiger, in den japanischen, deutschen und österreichischen Pharmakopöen fehlender Drogenblätter . . . . .	( 8 )	24
——: Studien über die Erkennung der Drogen auf Grund des Aschenbildes. (IV. Mitteilung). Blattaschenbilder wichtiger Krautdrogen. . . . .	(104)	371
KONDÔ, M. und ISSIKI, S.: Über das Erscheinen und Erbllichkeit von zwei teratologischen Reisarten . . . . .	(103)	369
—— ———: Über das Erscheinen und Erbllichkeit der Abnormalitäten bei der <i>Brassicazüchtung</i> . . . . .	(103)	370
——, OKAMURA, T., ISSIKI, S. und KASAHARA, Y.: Untersuchungen über "Photoperiodismus" der Reispflanzen. Erste Mitteilung . . . . .	( 38 )	128
KÔKETSU, R.: Die geeignete Menge des Pulvers zur Ausführung der Pulvermethode mit kleinerem Messungsfehler . . . . .	( 39 )	129
——: Über die Veränderung der Flächendimension und die dadurch verursachte Ungenauigkeit der auf die Flächeneinheit bezogenenen Rechnung der Grösse einer physiologischen Eigenschaft der Blätter . . . . .	( 39 )	130

KOSAKA, H.: Die Beziehungen zwischen den verschiedenen physiologischen Erscheinungen der Pflanzen und den an verschiedenen Vegetationsorganen tretenden Farbstoffen. III. Mitteilung. Über die Beziehungen zwischen der Wachstumstätigkeit und der Anthozyanbildung bei <i>Abutilon Avicennae</i> .—IV. Mitteilung. Über die Beziehungen zwischen dem Dasein des Anthozyanfarbstoffes und dem Grad der Assimilationstätigkeit bei einigen Kulturpflanzen . . . .	(8), (104)	25, 372
——: Beziehung zwischen der Assimilation und dem Vorhandensein von Anthozyan in den vegetativen Teilen bei einigen Kulturpflanzen .	(71)	252
——: Über den Einfluss des Lichtes, der Temperatur und des Wassermangels auf die Färbung der <i>Chrysanthemum</i> -Blüten . . . . .	(71)	253
——: Physiologisch -anatomische Untersuchungen über die Verteilung der an verschiedenen Vegetationsorganen in Erscheinung tretenden Anthozyanfarbstoffe von einigen Pflanzen . . . . .	(72)	254
KUDO, Y.: Materials for a flora of Formosa III-VI . . . . .	(9)	26
——: The mangrove of Formosa . . . . .	(39)	131
—— et MASAMUNE, G.: Genera plantarum formosanmarum. A description of all the genera of the vascular plants indigenous to Formosa and an enumeration of all the species, varieties and forms hitherto known in Formosa I. . . . .	(72)	255
—— and SASAKI, S.: An ecological survey of the vegetation of the border of Lake Jitsugetsutan . . . . .	(72)	256
—— et YAMAMOTO, Y.: Genus novum menispermacearum . . . . .	(39)	132
KUMAZAWA, M.: Morphological studies of <i>Anemonopsis</i> , <i>Actaea</i> and <i>Cimicifuga</i> . . . . .	(39)	133
——: The medullary bundle system in the Ranunculaceae and allied plants . . . . .	(40)	134
KURIBAYASHI, K.: Über eine Methode, um die Tatsache nachzuweisen, ob <i>Piricularia Oryzae</i> noch lebt oder nicht . . . . .	(9)	27
KUROSAWA, E.: Effect of temperature and medium upon the overgrowth phenomenon of rice seedlings caused by the excretion of the cultures of <i>Lisea Fujikuroi</i> SAW. . . . .	(9)	28
——: On certain experimental results concerning the over-elongation phenomenon of rice plants which owe to the filtrate got from the culture solution of the "bakanae"-fungi . . . . .	(72)	257
KUSANO, S.: The host-parasite relationship in <i>Olpidium</i> . . . . .	(41)	135
——: Dormancy in the summer sorus of <i>Synchytrium</i> . . . . .	(41)	136
KUWADA, Y.: The double coiled spiral structure of chromosomes . . .	(41)	137
*LILIENFELD, F. A.: Karyologische und genetische Studien an <i>Fragaria</i> . Ein tetraploider fertiler Bastard zwischen <i>F. nipponica</i> (n=7) und <i>F. elatior</i> (n=21) . . . . .	(104)	373
MAEDA, Y.: Cytological studies of <i>Colocasia</i> . . . . .	(73)	258
MAEKAWA, F.: A new species of <i>Equisetum</i> . . . . .	(42)	138

	Page Entry
MAEKAWA, F.: <i>Alabastra diversa</i> I . . . . .	(73) 259
MASAMUNE, G.: Contribution to our knowledge of the flora of the southern part of Japan IV-VIII . . . . .	(10), (42) 29, 140
——: A contribution to the phytogeography of the Island of Yakusima II (Angiospermae) . . . . .	(42) 139
——: A table showing the distribution of all the genera of flowering plants which are indigenous to the Japanese Empire . . . . .	(73) 260
——: <i>Symbolae florae australi-japonicae</i> I. . . . .	(73) 261
——: Phytogeographical position of Formosa when her indigenous genera are concerned . . . . .	(73) 262
——: Phytogeographical position of Formosa when her indigenous genera of vascular cryptogamic plants are concerned . . . . .	(74) 263
——: Notes on the orchid flora of Japan . . . . .	(74) 264
*——: Phytogeographical position of Japan concerning indigenous genera of vascular cryptogamic plants . . . . .	(104) 374
——, KAMIKÔTI, S. SUZUKI, T. et HUKUYAMA, N.: Étude des types biologiques d'après RAUNKIAER dans la flore aux environs de Garanbi. . . . .	(74) 265
MASUDA, T.: Studies on the elongation of petioles in some dicotyledons . . . . .	(104) 375
*MATSUMOTO, K.: Effect of seed-formation on the rate of respiration of the Japanese persimmon or kaki ( <i>Diospyros Kaki</i> L. fil.) . . . . .	(42) 141
——: Zur Kritik der Kryptogomerentheorie von BLEIER . . . . .	(105) 376
—— and OKABE, N.: On the causal organism of the bacterial soft rot of "kotyôran" ( <i>Phalaenopsis Aphridite</i> REICHENB. f.) . . . . .	(10) 30
—— ——— SOMAZAWA, K.: Immunological studies of mosaic diseases. I. Effect of formalization, trypsinization and heat-inactivation of tobacco mosaic juice Part I-II.—II. Distribution of antigenic substance of tobacco mosaic in different parts of host plants . . . . .	(10), (74) 31, 266
—— ——— ———: On the relationship between the serological reaction and other biological characters of some putrefactive phytopathogenic bacteria . . . . .	(43) 142
—— ——— ———: Physiology and the parasitology of the fungi generally referred to as <i>Hypochnus Sasakii</i> SHIRAI. I. Differentiation of the strains by means of hyphal fusion and culture in differential media . . . . .	(75) 267
MATSUURA, H.: A bibliographical monograph on plant genetics (Genic analysis) 1900-1922 . . . . .	(105) 377
MATSUURA, I.: Experimental studies on the saltation in fungi VI. (Preliminary report). On the saltation in the genus <i>Brachysporium</i> .—VII. On the mechanism of the occurrence of "island" type of saltation. . . . .	(75) 268, 269
MIKI, S.: Morphology of lotus ( <i>Nelumbo</i> ) flower, especially of two-headed flower . . . . .	(76) 270
——: Ecological studies of the forest of Jingu-shin-iki . . . . .	(76) 271
——: On sea-grasses new to Japan . . . . .	(76) 272



	Page	Entry
MIKI, S.:	(105)	On the pleistocene flora in prov. Yamashiro . . . . . 378
———:	(106)	On the regeneration of leaves and roots of some water and marine plants in Japan . . . . . 379
———:	(106)	Hydrophile Pflanzen aus Insel Etorohu . . . . . 380
MIURA, K.:	(76)	On the curvature of the culm of <i>Sasa kurilensis</i> . . . . . 273
MIWA, T.:	(43)	On the cell-wall constituents of brown algae . . . . . 143
MIYABE, K. and KUDO, Y.:	(11)	Icones of the essential forest trees of Hokkaido . . . . . 32
——— ———:	(11), (43)	Flora of Hokkaido and Saghalien II-III . . . . . 33, 144
——— ——— NAGAI, M.:	(77)	On <i>Hediphyllum Bongardianum</i> (P. et R.) YENDO and five species of <i>Laminaria</i> from the North Kuriles . . . . . 274
——— ——— ———:	(44)	<i>Cymathere crassifolia</i> (POSTELS et RUPRECHT) DE TONI from the Southern Kuriles . . . . . 145
——— ——— ———:	(44)	<i>Pleuropterum paradiseum</i> , a new genus and species of Alarieae from the Northern Kuriles . . . . . 146
MIYAKE, K. and KUNIEDA, H.:	(11)	On the conjugation of the gametes and the development of the zoospores in Ulvaceae . . . . . 34
MIYAZAWA, B.:	(44)	On the Matusima variegation in Japanese morning glory . . . . . 147
———:	(44)	On the two cases of semi-sterility in <i>Oryza sativa</i> . . . . . 148
MIYOSHI, M.:	(106)	On the disjunctive plant distribution in the Pacific regions from the natural protection point of view . . . . . 381
MORINAGA, T.:	(11), (106)	Interspecific hybridization in <i>Brassica</i> IV. The cytology of $F_1$ hybrids of <i>B. carinata</i> and some other species with 10 chromosomes.—*V. The cytology of $F_1$ hybrid of <i>B. carinata</i> and <i>B. albuglabra</i> . . . . . 35, 382
———:	(44)	The chlorophyll deficiencies in rice . . . . . 149
——— and FUKUSHIMA, E.:	(12)	Preliminary report on the haploid plant of rice, <i>Oryza sativa</i> L. . . . . 36
——— ——— ———:	(77)	Some observations on the microsporangium of the haploid plant of rice . . . . . 275
MORITA, H.:	(12)	On new species of the genera <i>Cinnamomum</i> and <i>Smilax</i> from the miocene deposits of Oguni-machi, Uzen province, Japan . . . . . 37
———:	(106)	Chronological distribution of fossil <i>Aralia</i> and a new species from Japanese neogene . . . . . 383
MORIYA, M.:	(77)	Chromosomzahlen und Fertilitätsverhältnisse in der Nachkommenschaft eines hypopentaploiden <i>Triticum</i> -Bastarde mit 34 somatischen Chromosomen . . . . . 276
MOTTE, J.:	(77)	Recherches sur les spermatozoïdes végétaux. I. Sur le rhéotactisme des spermatozoïdes de Filicinées . . . . . 277
NAGAI, I.:	(78)	The number of leaf-stomata in relation to a spot-leaved mutant in rice . . . . . 278
——— and SUZUKI, M.:	(78)	On the leaf-stomata of rice-plant . . . . . 279

	Page Entry
NAGAI, M.: Studies on the Japanese Saprolegniaceae. . . . .	(45) 150
——: Additional notes on the Japanese Saprolegniaceae . . . . .	(107) 384
NAGAO, S.: Number and behaviour of chromosomes in the genus <i>Narcissus</i> . . . . .	(107) 385
—— ——— TAKUSAGAWA, H.: Über die Chromosomen einiger Amaryllidaceen . . . . .	(73) 280
NAGATOMO, I.: Über das Verhalten von <i>Polyporus Schweinitzii</i> FR. in Mischkulturen . . . . .	(45) 151
NAKAI, T.: Notulae ad plantas japonicae and koreae XLI-XLII . (45), (78)	152, 281
——: <i>Hemerocallis japonica</i> . . . . .	(45) 153
——: An observation on the gametophyte of <i>Cheiropleuria bicuspis</i> var. <i>integrifolia</i> . . . . .	(107) 386
——: Notes on the Japanese ferns . . . . .	(107) 387
——: Nuntia ad plantas japoniae et koreae XLIII . . . . .	(108) 388
—— and MAEKAWA, F.: <i>Yoania amagiensis</i> NAKAI and F. MAEKAWA, a new species of <i>Yoania</i> . . . . .	(12) 38
NAKAJIMA, Y.: Über die Hartschaligkeit und die Quellung der Samen von <i>Astragalus sinicus</i> , L. . . . .	(12) 39
——: Experimente über die Keimung und Bewahrung der Samen von <i>Thujaopsis dolabrata</i> . . . . .	(108) 389
NAKAMORI, E.: On the appearance of the triploid plant of rice, <i>Oryza sativa</i> L. . . . .	(78) 282
NAKAMURA, M.: Karyological studies on the genus <i>Rhododendron</i> . . .	(13) 40
——: Daily changes in the occurrence of the imperfect pollen grains in <i>Impatiens Balsamina</i> LINN. . . . .	(79) 283
NAKAMURA, S.: Zytologische Beobachtungen über zwei Sippen steriler Reispflanzen . . . . .	(13) 41
*NAKATOMI, S.: Hybridization between Old World and New World cotton species and the chromosome behavior of the pollen mother-cells in the F <sub>1</sub> hybrid . . . . .	(13) 42
——: Differences in the peroxydase activity of the cotton species . . .	(79) 284
——: Effects of low temperature on the germination of pollen grains and seeds. . . . .	(108) 390
NAKAYAMA, K.: On the inheritance of anthocyan formation in rice with special reference to the colour of stigma . . . . .	(46) 154
——: The segregation in the size of grains in the cross between normal and dwarf races of rice. . . . .	(46) 155
*NAMIKAWA, I., SISA, M. and ASAI, K.: On the flower types of <i>Diospyros Kaki</i> , L. fil. . . . .	(79) 285
NISHIYAMA, I.: The genetics and cytology of certain cereals. II. Karyogenetic studies of fatuoid oats with special reference to their origin. IV. Further studies on fatuoid oats . . . . .	(13), (109) 43, 392

	Page	Entry
NISHIYAMA I.: On the mechanism of the fatuoid and speltoid mutation .	(109)	391
NISIKADO, Y.: Vergleichende Untersuchungen über die durch <i>Lisea Fujikuroi</i> SAW. und <i>Gibberella moniliformis</i> (SH.) WINEL. verursachten Gramineenkrankheiten . . . . .	i (14)	44
——: Beiträge zur physiologischen Spezialisierung einiger obstbewohnenden Fusarien . . . . .	(14)	45
——: Über eine neue einfache Methode, das Photographieren und das Zeichnen der Pilzsporen zu erleichtern . . . . .	(80)	287
—— und MATUMOTO, H.: Studien über die Bakanae-Krankheit . . . . .	(79)	286
——, ——, und YAMAUTI, K.: Zur Kenntnis der physiologischen Differenzierung der <i>Fusarium</i> -Arten I. Über den Unterschied der Pathogenität zwischen verschiedenen Stämmen des Bakanaepilzes von Reis . . . . .	(110)	394
——, ——, ———: Zur Kenntnis der physiologischen Differenzierung der <i>Fusarium</i> -Arten. II. Entwicklung verschiedener Stämme des Bakanaepilzes und Temperatur . . . . .	(110)	395
—— — YAMAUTI, K.: Contributions to the knowledge of the sap stain of wood in Japan I. Studies on <i>Ceratostomella ips</i> RUMBOLD, the cause of a blue stain of pine trees in Western Japan . . . . .	(110)	393
NODA, K.: Über die Korrelation zwischen der Keimungsfähigkeit der Maispollenkörner und den äussern Faktoren . . . . .	(14)	46
*NOGUCHI, Y.: Studies on the species crosses of Japanese <i>Rhododendron</i> . I. On the crossability between various species and the cotyledon color of F <sub>1</sub> seedlings . . . . .	(46)	156
NOHARA, S.: Genetic studies on <i>Platycodon</i> . . . . .	(46)	157
NOJIMA, T.: Studien über <i>Polyporus japonicus</i> FRIES . . . . .	(46)	158
OGURA, Y.: On a fossil tree stem from the upper cretaceous of Iwaki, Japan . . . . .	(15)	47
——: On the structure and affinities of some cretaceous plants from Hokkaido. Second contribution . . . . .	(47)	159
*——: On the structure of "hobashira-ishi," a famous silicified trunk at Najima near Fukuoka City . . . . .	(80)	288
*——: On the structure of a silicified wood found near "hobashira-ishi" at Najima near Fukuoka City . . . . .	(80)	289
*OHARA, K.: Mikrochemische Untersuchungen an über 1,800 Jahre lange aufbewahrten Holz—ein Beitrag zur Kohlenentstehungstheorie . . . . .	(111)	396
—— und ADACHI, K.: Über die Zersetzung der Holzzellwände durch Pilzfäden . . . . .	(47)	160
OHGA, I. and SINOTÔ, Y.: Cytological studies on <i>Sciaphila japonica</i> , MAK. (Prel. note). II. On pollen and embryo-sac development.—III. Mycorrhiza . . . . .	(47)	161
OHKI, K.: On the systematic importance of spodograms in the leaves of the Japanese Bambusaceae . . . . .	(80)	290

	Page Entry
OHTSUKI, T.: Studien über den Konjakmannan-Abbau bei Schimmelpilzen . . . . .	(81) 291
OHWI, J.: Symbolae ad floram Asiae orientalis III-VIII . . . . .	(15), (48), (81), (111) 48, 165, 293, 397
——: Contributions ad cariologiam Asiae orientalis. Pars altera . . .	(48) 162
——: Florula shikotanensis I-II . . . . .	(48), (81) 163, 292
——: <i>Mitella</i> of Japan . . . . .	(48) 164
OIKAWA, K.: Sex in <i>Stropharia semiglobata</i> . . . . .	(15) 49
OKABE, N.: Bacterial diseases of plants occurring in Formosa I. . . .	(81) 294
OKABE, S.: Parthenogenesis bei <i>Ixeris dentata</i> NAKAI . . . . .	(82) 295
OKADA, Y.: Study of <i>Euryale ferox</i> SALISB. VII. Change of catalase and germination percent during the after-ripening of the seeds . . .	(15) 50
OKAHARA, K.: Physiological studies on <i>Drosea</i> III. The effect of various acids on the digestion of protein by pepsin. IV. On the function of microorganisms in the digestion of insect bodies by insectivorous plants . . . . .	(15), (111) 51, 398
——: On the rôle of micro-organism in the digestion of insect bodies in insectivorous plants . . . . .	(48) 166
OKAMURA, K.: The distribution of marine algae in Pacific waters . . .	(48) 167
——: On the algae from Alaska collected by Y. KOBAYASHI . . . .	(111) 399
—— and ÔSHIMA, K.: Life-history of <i>Coccophora Langsdorffii</i> (TURN.) GREV . . . . .	(111) 400
*OKUNUKI, K.: Über die Beeinflussung des Wachstums der Schimmelpilze durch die von Rosahefen gebildeten Stoffe . . . . .	(16) 52
——: Über den Gaswchsel des Pollens . . . . .	(82) 296
——: Über den Gaswchsel des Pollens von <i>Lilium auratum</i> , LINDL. .	(111) 401
——: Über den Gaswchsel des Pollens von <i>Thea sinensis</i> , L. . . . .	(112) 402
ONO, T.: Polyploidy in <i>Rumex Acetosa</i> . . . . .	(49) 168
——: Chromosomes of <i>Rumex hastata</i> . . . . .	(112) 403
ONODERA, J.: On drought resistance, morphological and physiological modifications and variations of yields for various soil moisture contents in rice-plant . . . . .	(16) 53
ÔISHI, S.: On the fossil Dipteridaceae . . . . .	(82) 297
SAKAMURA, T. und YANAGIWARA, T.: Zur Bildung des Wuchsstoffes bei <i>Aspergillus niger</i> . . . . .	(83) 298
SAKURAI, K.: Beobachtungen über japanische Moosflora I-IV. . . . .	(49), (83), (112) 169, 299, 404
SATAKE, Y.: Systematic and anatomical studies on the Japanese Junceaceae (2)-(3) . . . . .	(16), (83) 54, 300
——: Systematic and anatomical studies on the Japanese plants I . .	(17) 55



	Page	Entry
SATAKE, Y.: Juncaceae of the Aleutian Islands collected by Mr. Y. KOBAYASI in 1931 . . . . .	(49)	170
SATO, S.: Studien über die Wirkungen der durch <i>Ophiobolus Miyabeanus</i> gebrauchten Nährlösungen auf die Keimung und Entwicklung eines anderen Pilzes . . . . .	(49)	171
——: Über die Verarbeitung der Zellulose durch einige krankheitserregende Pilze . . . . .	(49)	172
SATÔ, K.: Systematische Bedeutung der Zahlenverhältnisse der Zapfen bei einigen Nadelhölzern . . . . .	(17)	56
——: Botanische Studien von Sirahatakiefer mit besonderer Berücksichtigung des anatomischen Baues der Blätter . . . . .	(17)	57
SATÔ, K.: Studien über die Frühling- und Winterformen von Gerste. II. Über den Unterschied der Saugkraft der Samenkörner. SATÔ, K. und YOSINAGA, W.—III. Unterschied der Chlorophyllmenge. SATÔ, K.—IV. Kältewiderstand, Trockensubstanzmenge und physikalische Eigenschaften des Zellsaftes. SATÔ, K. und NAKASIMA, S. . . . .	(83)	301
—— and YUMIYAMA, H.: Studies on the summer and winter forms in barley. I. On the difference in susceptibility to illumination . . . .	(49)	173
SATÔ, M.: Chromosome studies in <i>Lilium</i> , I . . . . .	(50)	174
SAWADA, K.: Materials of the Formosan fungi (28)–(29). . . . .	(18), (84)	58, 302
——: A list of fungi found in Formosa . . . . .	(18)	59
SAWADA, T.: Studies on flowering, pod-bearing and seed-setting habits of alfalfa . . . . .	(84)	303
SETO, F.: Experimentelle Untersuchungen über die hemmende und die beschleunigende Wirkung des Erregers sog. "Bakanae"-Krankheit, <i>Lisea Fujikuroi</i> SAWADA, auf das Wachstum der Reiskeimlinge. . . .	(50)	175
SHIBATA, M.: Studien über die Bildung organischer Säuren bei <i>Begonia Evansiana</i> ADER. . . . .	(51)	176
——: Studien über die Bildung organischer Säuren. I. Die Reihenfolge des Säuregehalts im ganzen Körper in <i>Begonia Evansiana</i> ANDER. . . . .	(51)	177
SHIGENAKA, M.: On the action of sodium glycocholate on nuclei and chromosomes . . . . .	(112)	405
SHIMADA, S.: Further studies on the nature of the growth-promoting substance excreted by the "bakanae"-fungus . . . . .	(51)	178
——: Size of the cells in "bakanae"-seedlings . . . . .	(112)	406
——: Change of pathogenicity shown by the "bakanae"-fungus, <i>Gibberella Fujikuroi</i> . . . . .	(113)	407
SHIMAMURA, T.: A note on the mitotic division in the proembryo of <i>Ginkgo</i> , with special reference to a chromatin-elimination . . . .	(18)	60
SHIMOTOMAI, N.: Über die abnorme Reduktionsteilung in P.M.Z., die einen riesigen Kern oder überzählige Zweigkerne enthalten . . . .	(18)	61

	Page Entry
SHIMOTOMAI, N.: Über die Entstehung neuer konstanten fruchtbaren 4n Bastardes bei <i>Chrysanthemum</i> .—Bastardierungsversuche bei <i>Chrysanthemum</i> . II. Entstehung eines fruchtbaren Bastardes aus der Kreuzung von <i>C. marginatum</i> (haploid 5n) mit <i>C. morifolium</i> (hapl. 3n) . . . . .	(51) 179
——: Geschlechtschromosomen bei <i>Pogonatum inflexum</i> LINB. und Chromosomenzahlen bei einigen anderen Laubmoosen . . . . .	(52) 180
——: Chromosomenzahlen bei japanischen Gartenrassen von <i>Chrysanthemum</i> . . . . .	(85) 304
——: Eigenartige Vermehrung der Chromosomenzahl bei den Artbastarden von <i>Chrysanthemum</i> . . . . .	(85) 305
SHINKE, N. and SHIGENAKA, M.: A histochemical study of plant nuclei in rest and mitosis . . . . .	(113) 408
SINOTÔ, Y. and KIKKAWA, R.: Cytogenetical studies on <i>Tricyrtis</i> . I. Chromosomen in <i>Tricyrtis</i> (Preliminary note). . . . .	(52) 181
SISA, M.: Relationship between the age and the viability of pollen in different cucurbits . . . . .	(85) 306
SKVORTZOW, B.W.: Beitrag zur Kenntnis der Flagellaten aus Mukden, Mandschurei . . . . .	(113) 409
SUDÔ, T.: Über den Einfluss der Sonnenbeleuchtungsdauer auf das Blühen bei einigen <i>Quamoclit</i> arten . . . . .	(86) 307
SUGIURA, T.: A list of chromosome numbers in angiospermous plants. . . . .	(19) 62
SUTÔ, T. Conspectus caricum florulae simotukensis . . . . .	(113) 410
SUZUKI, S.: Florula taiheizanensis . . . . .	(86) 308
——: An ecological study of the vegetation of Mt. Taiheizan. (A preliminary paper) . . . . .	(86) 309
TAGAWA, M.: Spicilegium pteridographiae Asiae orientalis I-III. (52), (86) 182, 310	
——: Symbolae pteridographiae Asiae orientalis IV . . . . .	(114) 411
TAHARA, M.: Chromosome morphology in <i>Smilacina japonica</i> . . . . .	(114) 412
TAHATA, K., OGATA, K. und SUKEKAWA, K.: Über den Einfluss der Tagesdauer über das Wachstum, Blühen und Fruchtbildung bei Buchweizen und Sojabohne . . . . .	(19) 63
TAKEDA, H. und TANABE, K.: Photographiensammlung der japanischen alpinen Pflanzen . . . . .	(52) 183
TAKENAKA, Y.: Further reports of cytological and genetic investigations of <i>Rumex Acetosa</i> L. I. New chromosome and chromosome fragments . . . . .	(19) 64
——: Further reports of the cytological investigations on the sterile plants . . . . .	(20), (114) 65, 413
——: On the irregular meiotic division in the pollen mother-cells in <i>Lilium tigrinum</i> KER-GAWL. . . . .	(114) 414
TAKENOUCHI, M.: The genus <i>Viola</i> in Kyûsyû 1 . . . . .	(52) 184
——: A short report on the vegetation of the Kudju mountain ranges . . . . .	(86) 311

	Page Entry
TAKENOUCHI, M.: On a new variety of <i>Viola xanthopetala</i> NAKAI . . .	(87) 312
——: Observation on the teratological flowers and bracts of <i>Viola obtusa</i> MAKINO . . . . .	(87) 313
——: Investigations on the relation between plants and their surrounding conditions by the quantitative method. V. Measurement of dimension of leaf intercellular spaces on several species of plants and its ecological significance.—VI. Variation of wavyness in the lateral walls of epidermal cells of leaves of <i>Taraxacum albidum</i> DAHL. as related to meteorological conditions and its practical value as a phytometer . . . . .	(114) 415
TAKEZAKI, Y.: The inheritance of some lax varieties in rice . . . . .	(87) 314
TAKIGUCHI, Y.: On the DAVIS' catalase method modified for prophesying the germinating power of seeds . . . . .	(87) 315
TAMAOKI, B.: Untersuchung über den Einfluss des Welkens auf die Anhäufung der Assimilate in den Blättern durch die Anwendung der "Pulvermethode" . . . . .	(53) 185
TAMIYA, H.: Über die Verwendbarkeit von verschiedenen Kohlenstoffverbindungen im Bau- und Betriebsstoffwechsel der Schimmelpilze. (Studien über die Stoffwechselphysiologie von <i>Aspergillus oryzae</i> IV). . . . .	(53) 186
——: Zur Theorie des respiratorischen Quotienten nebst einer Bemerkung über den Einfluss der oxydoreduktiven Zellvorgänge auf den Gaswechsel der Zelle. Beiträge zur Atmungsphysiologie der Schimmelpilze I . . . . .	(88) 316
——: Zur Energetik des Wachstums. Beiträge zur Atmungsphysiologie der Schimmelpilze II . . . . .	(88) 317
——: Über die Stoff- und die Energiebilanz bei dem Wachstumvorgang des Schimmelpilzes. Bemerkung zu der Arbeit von L. ALGERA . . . . .	(115) 416
—— und YAMAGUTCHI, S.: Über die Aufbau- und die Erhaltungssatmung. Beiträge zur Atmungsphysiologie der Schimmelpilze. . . . .	(116) 417
TANAKA, H.: The genetics and cytology on some varieties and hybrids in Japanese tobaccos . . . . .	(116) 418
TANAKA, K.: Zur Physiologie der Essigsäuregärung. II. Über die Einwirkung des Kaliumcyanids und des Acetons und über die Dismutation . . . . .	(54) 187
TANAKA, T.: A monograph of the Satsuma orange with special reference to the occurrence of new varieties through bud variation . . . . .	(89) 318
TASUGI, H.: Studies on the physiology of the conidiphores, conidia and oospores of <i>Sclerospora graminicola</i> (SACC.) SCHROET. . . . .	(117) 419
—— and KUMAZAWA, M.: <i>Phytophthora</i> blight of peony . . . . .	(55) 188
TATEWAKI, M.: Alpine flora of Mt. Horonupuri, Kitami ranges, Hokkaido, Japan . . . . .	(117) 420
—— and KIMOTO, U.: Florula of the Island of Kaibatô (Todomoshiri) . . . . .	(89) 319

	Page Entry
TATUNO, S.: Geschlechtschromosomen bei einigen Lebermoosen I-II . . . . .	(117), (118) 421, 422
TERASAWA, Y.: Tetraploide Bastarde von <i>Brassica chinensis</i> und <i>Raphanus sativus</i> . . . . .	(55) 189
——: Konstante amphidiploide <i>Brassica-Raphanus</i> Bastarde . . . . .	(89) 320
——: Über die Fruchtgestalt der Bastarde zwischen <i>Brassica</i> und <i>Raphanus</i> . . . . .	(118) 423
TEZIMA, T.: Über die Vererbung der Samenhautfarbe bei <i>Sesamum indica</i> . . . . .	(20) 66
TOCHINAI, Y.: The black rot of rice-grains caused by <i>Pseudomonas Itoana</i> , n. sp. . . . .	(56) 190
—— and SHIMADA, S.: <i>Sporotrichum Narcissi</i> sp. nov. parasitic on <i>Narcissus</i> bulbs . . . . .	(56) 191
—— ———: Further notes on <i>Narcissus</i> bulb-rot. . . . .	(56) 192
—— ——— SHIMAMURA, M.: Studies on the physiological specialization in <i>Piricularia Oryzae</i> BR. et COV. . . . .	(56) 193
—— ——— TERUI, M.: Studies on the effects of fat-soluble vitamin upon the growth of some parasitic fungi . . . . .	(56) 194
TOGASHI, K.: Cardinal temperatures of pea-wilt, <i>Fusaria</i> in culture . . . . .	(20) 67
——: Studies on the pathology of peach canker . . . . .	(20) 68
——: Freezing of plants in the late autumn and early winter . . . . .	(118) 424
*—— and UCHIMURA, K.: A contribution to the knowledge of parasitism of <i>Valsa Paulowniae</i> , in relation to temperature . . . . .	(119) 425
TOMITA, K.: Befruchtung und Kernteilung bei <i>Coccophora Langsdorffii</i> (TURN.) GREV. . . . .	(57) 195
TORYU, Y.: On the organic iodine in <i>Laminaria ochotensis</i> MIYABE with especial reference to protein iodine, and search for diiodothyrosine . . . . .	(119) 426
*U, N.: On the reappearance of haploid in the Japanese morning glory . . . . .	(119) 427
—— and NAGAMATU, T.: On the difference between <i>Brassica campestris</i> L. and <i>B. Napus</i> in regard to fertility and natural crossing . . . . .	(57) 196
UCHIKAWA, I.: Karyological studies in Japanese bamboos I. The chromosome number of several species. . . . .	(119) 428
UYEKI, H.: Cupuliferae koreanae. . . . .	(90) 321
——: On the forest zone of Korea . . . . .	(119) 429
WADA, B.: Mikrurgische Untersuchungen lebender Zellen in der Teilung. I. Die Bildung von Tetraploidkernen, zweikernigen Zellen und anderen abnormen Teilungsbildern. . . . .	(90) 322
——: Mikrodissektion der Chromosomen von <i>Tradescantia reflexa</i> . (Vorl. Mit.) . . . . .	(119) 430
WAKAKUWA, S.: A karyological study on the triploid hybrid of the genus <i>Celosia</i> . . . . .	(22) 69



	Page	Entry
WAKAYAMA, K.: Contributions to the cytology of fungi. III. Chromosome number in <i>Aspergillus</i> . . . . .	(23)	70
——: Contributions to the cytology of fungi. Chromosome number in Autobasidiomycetes . . . . .	(58)	197
WATANABE, A.: Über die Bedeutung der Nährbakterien für die Entwicklung der Myxomyceten-Plasmodien . . . . .	(58)	198
——: Über die Beeinflussung der Atmung von einigen grünen Algen durch Kaliumcyanid und Methylenblau . . . . .	(90)	323
——: Über die Bedeutung der Nährhefen für die Entwicklung von Myxomyceten-Plasmodien . . . . .	(120)	431
WATANABE, S.: Physiological studies in the pine-apple roots . . . . .	(58)	199
YABE, Y.: On the sexual reproduction of <i>Prasiola japonica</i> . YATABE . . . . .	(58)	200
YAMADA, Y.: Notes on some Japanese algae III-V . . . . .	(59), (91), (120)	201, 324, 432
YAMAGUTI, Y.: Kreuzungsuntersuchungen an Reispflanzen. III. Genetik der Farbeigenschaften verschiedener Pflanzenteile, des Wuchshabitus und der Ausschusszeiten. (Zugleich ein Beitrag zur Kenntnis der Koppelungsgruppe beim Reis) . . . . .	(23)	71
——: Über elektrische Potentialveränderungen an periodisch sich bewegenden Primärblättern von <i>Canavalia ensiformis</i> DC. . . . .	(59)	202
YAMAHA, G.: Über die Färbbarkeit der fixierten Zellstrukturen . . . . .	(59)	203
——: Über den isoelektrischen Punkt der Bakteriensuspensionen . . . . .	(91)	325
——: Über den isoelektrischen Punkt des pflanzlichen Zellkernes . . . . .	(91)	326
—— und ISHII, T.: Über die Ionenwirkung auf die Chromosomen der Pollenmutterzellen von <i>Tradescantia reflexa</i> L. . . . .	(60)	204
YAMAMOTO, A.: Über den Einfluss einiger Gifte und der Temperatur auf die Ausnutzung der Atmungsenergie beim Wachstum des Schimmelpilzes . . . . .	(120)	433
YAMAMOTO, K.: Über den Nachweis von Oxydasen bei holzzersetzenden Pilzen . . . . .	(60)	205
YAMAMOTO, K. and SAKAI, K.: On chromosome number in some Solanaceae . . . . .	(91)	327
YAMAMOTO, Y.: Observationes ad floram formosanam I-V . . . . .	(24), (92)	72, 207, 328
——: Synopsis specierum generis <i>Balanophorae</i> in Japonia et Formosa sponte crescentium . . . . .	(60)	206
——: Supplementum plantarum formosanarum V . . . . .	(60)	208
——: Contributiones ad floram formosanum IV . . . . .	(92)	329
——: Species novae orchidacearum ex insula Ponape . . . . .	(121)	434
YAMAMOTO, Y.: An autohexaploid plant of <i>Rumex acetosa</i> . . . . .	(121)	435
YAMASAKI, M.: On the growth of seedlings of wheat varieties distinguished by their power of cold resistance . . . . .	(24)	73
*——: Identification of the sexes in dioecious plants by testing the resistance to the toxic action of chlorate . . . . .	(121)	436

	Page Entry
YASUDA, S.: Physiological researches on the fertility in <i>Petunia violacea</i> IX. Some new experiments on the special substances which inhibit self-fertilization existing in the pistil.—X. On the relation between the self-compatibility and the tissue-juice of the ovary.—XI. On the effect of temperature upon self-fertilization. . . . . (24), (92), 74, 330, 331	
——: On the special substance that inhibits self-fertilization. Physio- logical consideration on its nature based on the results of the experi- ments on the fertility of <i>Petunia violacea</i> . . . . . (61) 209	
YASUI, K.: Cytological studies in artificially raised interspecific hybrids in <i>Papaver</i> III. Unusual cases of cytokinesis in pollen mother-cells in a F <sub>1</sub> plant . . . . . (25) 75	
——: Genetical studies on <i>Zea Mays</i> L. . . . . (121) 437	
YENDO, Y. and TAKASE, K.: On a new species of the fungus parasitic on mulberry. . . . . (92) 332	
——: On the root-tubercles of <i>Elaeagnus</i> . . . . . (93) 333	
YOSHII, H.: On the pathogenic organism of the leaf spot disease of <i>Gomphrena globosa</i> . . . . . (122) 438	
YOSHII, Y.: Revegetation of volcano Komagatake after the great erup- tion in 1929 . . . . . (61) 210	
—— und HAYASI, N.: Botanische Studien subalpiner Moore auf vulka- nischer Asche . . . . . (25) 76	
—— JIMBO, T.: Mikrochemischer Nachweis von Aluminium und sein Vorkommen im Pflanzenreiche . . . . . (61) 211	
YOSIDA, K.: Über die Keimung des Pollens bei den <i>Linum</i> arten. . . . (62) 212	
YUASA, A.: Studies in the cytology of Pteridophyta. I. On the sperma- tozoid of <i>Pteris cretica</i> L. var. <i>albolineata</i> HK.—II. The morphology of spermatozoids of some ferns . . . . . (62), (122) 213, 439	

## DATE OF PUBLICATION

Transactions 1-237, March 18, 1932; 239-305, September 12, 1932; 307-487, May 31, 1933; 489-513, December 20, 1933.

Abstracts (1)-(26), March 18, 1932; (27)-(62), September 12, 1932; (63)-(93), May 31, 1933; (95)-(122), December 20, 1933.

# Inoculation experiments with some heteroecious species of the Melampsoraceae in Japan

By Naohide HIRATSUKA

(Received September 9, 1931)

## Introduction

In the course of his study on the Melampsoraceae, the writer has carried on cultural experiments on the species belonging to this group for the past eight years. From among the data of his investigations, it is intended to report the results of the inoculation experiments with some heteroecious species in this paper.

Most of the experiments reported in the following were carried out in the Botanical Institute, Faculty of Agriculture, Hokkaido Imperial University at Sapporo and a part of them in the Botanical Laboratory of the Tottori Agricultural College at Tottori.

## Historical review

In 1899, M. SHIRAI (15)<sup>(1)</sup> first proved by inoculations, that the aecidial stage of *Cronartium Quercuum* MIYABE is *Peridermium giganteum* (MAYR) TUBEUF forming galls of pine and that it occurs on the leaves of *Quercus serrata* THUNB. (*Q. acutissima* CARR.),<sup>(2)</sup> *Q. glandulifera* BL. (*Q. serrata* THUNB.) and *Q. variabilis* BL. This is the first record of investigations of heteroecism of the rust fungi in our country. Since that time, the life histories of Japanese species of the Melampsoraceae have been studied by K. MIYABE, T. MATSUMOTO, S. KAMEI and the writer.

In 1915, MIYABE (14) reported that a *Chrysomyxa* on *Rhododendron brachycarpum* D. DON (*Rh. Fauriae* FRANCH. var. *rufescens* NAKAI) and *Rh. chrysanthum* PALL. collected in Hokkaido, is identical with

---

(1) Reference is made by number to "Literature cited" (p. 33).

(2) The names in parentheses are added by the writer, which are now considered to be the correct names by the later studies.

*Chrysomyxa expansa* DIET. and its aecidial stage could be produced on the leaves of *Picea jezoensis* CARR. by inoculating them with sporidia from the teleutospores on *Rhododendron Fauriae* var. *rufescens*. He also stated that its aecidial stage is identical with *Peridermium Piceae-hondoensis* DIET. on *Picea hondoensis* MAYR. which was collected by S. KUSANO on Mt. Fuji, province of Suruga.

In 1914, MATSUMOTO studied the life histories of *Melampsora* parasitic on some species of *Salix* growing in the vicinity of Sapporo, and in the next year, he (11) published some of his investigations under the title, "Impfversuche mit *Melampsora* auf japanischen Weiden" in the Transactions of Sapporo Natural History Society, Volume 6. According to his careful study, the following four species: *Melampsora Larici-epitea* KLEB. on *Salix viminalis* L. var. *jezoensis* C. K. SCHN., *Melampsora Larici-daphnoidis* KLEB. on *Salix daphnoides* LEDEB. (*S. rorida* LACKS.), *Melampsora Larici-Miyabeana* MIYABE et MATSUMOTO on *Salix Miyabeana* v. SEEM. and *Melampsora Larici-opaca* MIYABE et MATSUMOTO on *Salix opaca* ANDERS. (*S. sachalinensis* FR. SCHM.) have these aecidial stages on species of *Larix*, and one species, *Melampsora jezoensis* MIYABE et MATSUMOTO on *Salix jessoensis* v. SEEM. has its stage on *Corydalis ambigua* CHAM. et SCHLECHT. After four years, MATSUMOTO (12) also recorded some results of cultural experiments with *Melampsora* on some species of *Populus* and *Salix* occurring in the vicinity of Sapporo. He created a new species, *Melampsora Larici-Urbaniانا* MATSUMOTO having its aecidial stage on species of *Larix* and its uredo- and teleutostage on *Salix Urbaniانا* v. SEEM. and a species, *Melampsora Larici-populina* KLEB. on species of *Larix* (its aecidial stage) and *Populus balsamifera* L. (*P. Maximowiczii* A. HENRY) was newly added to the mycological flora of our country. Besides them, he reported that a *Melampsora* on *Salix babylonica* L. has its aecidial stage on the leaves of *Chelidonium majus* L., and a species on *Salix Caprea* L. (*S. Bakko* KIMURA) collected in the vicinity of Sapporo seems to have an aecidial stage neither on leaves of *Larix* sps. nor *Abies* sps. In 1924, MATSUMOTO (13) further stated the results of cultures with a *Melampsora* having its aecidial stage on *Corydalis incisa* PERS. and *Chelidonium majus*, and its uredo- and teleutostage on *Salix Pierotii* MIQ. found in the vicinity of Morioka. And it was described as a new species, *Melampsora Chelidonii-Pierotii* MATSUMOTO.

In 1930, KAMEI (8) published his detailed studies on heteroecism of *Milesina vogesiaca* SYD. on *Polystichum Braunii* FÉE. In the next



year, he (7) reported the results of his investigations on the genetic relationship of *Uredinopsis Pteridis* DIET. et HOLW.

The writer (1, 2, 3, 4) has already described a part of the results of his studies on some species of the family in some papers.

## Methods

*Inoculations with the teleutospores.* The heavily affected teleuto-materials were collected in autumn, and they were placed out of doors or were kept in a cellar, inclosing them in a cotton bag. Just before the opening of buds of the inoculated plant in the next spring, several leaves of the teleuto-materials were taken out and placed in a Petri-dish which was beforehand lined with a moistened filter paper. As soon as the sporidia began to be produced, the inoculations were conducted. The inoculum was merely placed upon the leaves of a potted seedling which was sprayed thoroughly with water and covered with a bell-jar or put into an inoculation chamber. Two or three days after, the treated pot was transferred from the bell-jar or the inoculation chamber to a cool place and well watered every day.

*Inoculations with the aecidiospores.* The aecidiospores obtained from the well-developed and fresh sori were used. The method used was to make a spore suspension and spray it on the leaves of the plant by means of an atomizer. In several series of the experiments in *Cronartium Quercuum*, the method used was to make a spore suspension and put it on the leaves by means of a brush. The inoculated plant was covered with a bell-jar or put into an inoculation chamber after sowing of the aecidiospores. After two or three days, the treated pot was transferred from the bell-jar or the inoculation chamber. When the experiment was attempted in the field, the inoculated plant was uncovered after inoculation.

## Experiments

### 1. *Melampsora Larici-epitea* KLEB.

*Experiment I.* On November 11, 1924, the well-developed teleutospores on leaves of *Salix viminalis* var. *yezoensis* were collected on the river bank of the Toyohira near Sapporo, and the sporidia from the teleutospores were inoculated on the needles of *Larix Kaempferi* in May of the next year. The results are as follows:

TABLE 1

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix viminalis* var. *yezoensis*—1.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
1	<i>Larix Kaempferi</i>	May 7, 1925	May 17	May 20

*Experiment II.* In this series, the teleutospores on *Salix viminalis* var. *yezoensis* collected at Maruyama near Sapporo on November 14, 1925 were used as inoculum. The sporidia were inoculated on *Larix Kaempferi* in the next spring, and positive results were obtained as in Experiment I.

TABLE 2

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix viminalis* var. *yezoensis*—2.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
2	<i>Larix Kaempferi</i>	April 26, 1926	May 5	May 8

*Experiment III.* Inoculations with the aecidiospores from Experiment II were made on leaves of *Salix Bakko*, *S. Miyabeana*, *S. rorida*, *S. viminalis* var. *yezoensis* and *Populus Maximowiczii*. The results are shown in the following table.

TABLE 3

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-epitea* from *Salix viminalis* var. *yezoensis*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
3	<i>Salix Bakko</i>	May 16, 1926	—
4	<i>S. Miyabeana</i>	May 16, 1926	—
5	<i>S. rorida</i>	May 16, 1926	—
6	<i>S. viminalis</i> var. <i>yezoensis</i>	May 16, 1926	May 25
7	<i>Populus Maximowiczii</i>	May 16, 1926	—

Uredosori occurred abundantly on the inoculated leaves of *Salix viminalis* var. *yezoensis*, while no sign on the remaining plants appeared.

*Experiment IV.* The sporidia from the teleutospores on the leaves of *Salix rorida* which had been collected on the river bank of the Toyohira near Sapporo November 3 of 1925, were inoculated on needles of *Larix Kaempferi*, and positive results were secured as in the following table.

TABLE 4

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix rorida*.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
8	<i>Larix Kaempferi</i>	April 25, 1926	May 3	May 7

*Experiment V.* In this experiment, the aecidiospores from Experiment IV were used as inoculum. The inoculations were made on leaves of *Salix Bakko*, *S. jessoensis*, *S. Miyabeana*, *S. rorida* and *S. sachalinensis*. The results are shown in the following table.

TABLE 5

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-epitea* from *Salix rorida*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
9	<i>Salix Bakko</i>	May 11, 1926	
10	<i>S. jessoensis</i>	May 11, 1926	—
11	<i>S. Miyabeana</i>	May 11, 1926	—
12	<i>S. rorida</i>	May 11, 1926	May 19
13	<i>S. sachalinensis</i>	May 11, 1926	—

As shown in the table, uredosori occurred only on *Salix rorida*, while on the remaining species the inoculations were unsuccessful.



*Experiment VI.* In this series, the teleutospores on *Salix Miyabeana* collected on the river bank of the Toyohira near Sapporo on November 11, 1924, were used for inoculations. The sporidia were inoculated on *Larix Kaempferi* in the next spring, and the positive results were obtained as follows :

TABLE 6

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix Miyabeana*—1.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
14	<i>Larix Kaempferi</i>	May 5, 1925	May 14	May 19

*Experiment VII.* The teleutospores on *Salix Miyabeana* which had been collected at the same place as in Experiment IV on November 3, 1926, were used as inoculum. On April 29 of the next year, the sporidia obtained from the above mentioned materials were inoculated on *Larix Kaempferi*, and the results were the same as in Experiment VI.

TABLE 7

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix Miyabeana*—2.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
15	<i>Larix Kaempferi</i>	April 25, 1926	May 9	May 14

*Experiment VIII.* Inoculations with the aecidiospores from Experiment VII were made on *Salix Bakko*, *S. jessoensis*, *S. Miyabeana*, *S. rorida* and *S. sachalinensis*. The results of the experiment are shown in the following table.

TABLE 8

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-epitea* from *Salix Miyabeana*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
16	<i>Salix Bakko</i>	May 16, 1926	—
17	<i>S. jessoensis</i>	May 16, 1926	—
18	<i>S. Miyabeana</i>	May 16, 1926	May 26
19	<i>S. rorida</i>	May 16, 1926	May 27
20	<i>S. sachalinensis</i>	May 16, 1926	—

Uredosori abundantly occurred on the inoculated leaves of *Salix Miyabeana*, and slight infection showed on *Salix rorida* with slight development of sori, while on the remaining species inoculations were unsuccessful.

*Experiment IX.* In this experiment, the teleutospores on *Salix sachalinensis* collected on the river bank of the Toyohira on November 11, 1924, were used as inoculum. The inoculations were made with the sporidia from the teleutospores on the needles of *Larix Kaempferi*. Successful results were obtained as in the following table.

TABLE 9

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix sachalinensis*—1.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
21	<i>Larix Kaempferi</i>	May 7, 1925	May 16	May 20

*Experiment X.* In this series, inoculations with the sporidia from the teleutospores on *Salix sachalinensis* collected at the same place as in Experiment IX on November 18, 1925, were made on *Larix Kaempferi*. The results are the same as in Experiment IX showing in the following table.

TABLE 10

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix sachalinensis*—2.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
22	<i>Larix Kaempferi</i>	April 24, 1926	May 1	May 7

*Experiment XI.* As the inoculum, teleutospores on *Salix sachalinensis* collected at the foot of Mt. Daisen, province of Hôki were used. The sporidia produced from the teleutospores were inoculated on leaves of *Abies Mayriana*, *Chelidonium majus* and *Larix Kaempferi*, and results were obtained as in the following table.

TABLE 11

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-epitea* on *Salix sachalinensis*—3.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
23	<i>Abies Mayriana</i>	April 2, 1931	—	—
24	<i>Chelidonium majus</i>	April 2, 1931	—	—
25	<i>Larix Kaempferi</i>	April 2, 1931	April 15	April 20

From the preceding table, it may be seen that uredosori were produced on *Larix Kaempferi*, while on *Abies Mayriana* and *Chelidonium majus* inoculations were unsuccessful.

*Experiment XII.* This experiment was carried out in order to determine the return infection with the aecidiospores on species of *Salix*. The aecidiospores from Experiment X were used as inoculum. The results are shown in the following table.



TABLE 12

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-epitea* from *Salix sachalinensis*—1.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
26	<i>Salix Bakko</i>	May 13, 1926	—
27	<i>S. jessoensis</i>	May 13, 1926	—
28	<i>S. Miyabeana</i>	May 13, 1926	—
29	<i>S. rorida</i>	May 13, 1926	—
30	<i>S. sachalinensis</i>	May 13, 1926	May 22

From the above table, it may be seen that uredosori appeared only on *Salix sachalinensis*, while no sign on the other species of *Salix* occurred.

*Experiment XIII.* In this experiment, inoculations were made with the aecidiospores on leaves of *Salix Bakko*, *S. daisenensis* v. Seem., *S. sachalinensis* and *S. viminalis* var. *yezoensis*. The results of the experiment are as follows :

TABLE 13

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-epitea* from *Salix sachalinensis*—2.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
31	<i>Salix Bakko</i>	April 30, 1931	—
32	<i>S. daisenensis</i>	April 30, 1931	—
33	<i>S. sachalinensis</i>	April 30, 1931	May 8
34	<i>S. viminalis</i> var. <i>yezoensis</i>	April 30, 1931	—

**Remarks.** In 1915, MATSUMOTO (11) divided *Melampsora* on species of *Salix* found in the neighbourhood of Sapporo whose aecidial stage occur on species of *Larix*, into the following four different species; *Melampsora Larici-epitea* KLEB. on *Salix viminalis* var. *yezoensis*, *Mel-*

*ampsora Larici-daphnoidis* KLEB. on *Salix rorida*, *Melampsora Larici-Miyabeana* MIYABE et MATSUMOTO on *Salix Miyabeana* and *Melampsora Larici-opaca* MIYABE et MATSUMOTO on *Salix sachalinensis*. According to his opinion, differences among these species depend chiefly upon the biological characters shown by his inoculation experiments. He also pointed out the position of the teleutosori in its classification.

The writer made careful observations on the morphology and biology of these fungi on four species of *Salix*, but detected no remarkable differences in separating into different species. Therefore, he came to the conclusion that those four species stated by MATSUMOTO are included under a collective species, *Melampsora Larici-epitea* KLEB. But, each form on the four species of *Salix*, viz. *Salix Miyabeana*, *S. rorida*, *S. sachalinensis* and *S. viminalis* var. *yezoensis* is specialized biologically as shown in the results of the preceding experiments.

Moreover, by the writer's examination the following conclusions are obtained.

1) The form on *Salix viminalis* var. *yezoensis* is exactly identical with *Melampsora Larici-epitea* KLEB. forma *epiphylla* stated by KLEBAHN (9).

2) The form on *Salix rorida* does not agree with *Melampsora Larici-epitea* KLEB. f. sp. *Larici-daphnoidis* KLEB. (*Melampsora Larici-daphnoidis* KLEB.) The teleutosori of the present fungus are amphigenous, mostly epiphyllous and its teleutospores subcuticular, while those of European form are mostly hypophyllous and teleutospores subepidermal.

3. No morphological difference can be observed between the form on *Salix Miyabeana* and that on *Salix sachalinensis*.

## 2. *Melampsora Larici-Capraearum* KLEB.

*Experiments I and II.* On April 25, 1926, sporidia from the overwintered teleutospores of this species on *Salix Bakko* collected by the writer at Maruyama near Sppporo (Nov. 14, 1925) were inoculated on the leaves of *Larix Kaempferi* and got the positive results shown in Table 14. He also inoculated the aecidiospores on *Larix Kaempferi* from cultural experiments, on the leaves of the following four species of *Salix*; *Salix Bakko*, *S. Miyabeana*, *S. rorida* and *S. viminalis* var. *yezoensis*, but, uredosori appeared only on the inoculated leaves of *Salix*

*Bakko*, while no sign of infection on the remaining species of *Salix* appeared, as shown in Table 15.

TABLE 14

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-Capraearum* on *Salix Bakko*.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caemata
35	<i>Larix Kaempferi</i>	April 25, 1926	May 5	May 11

TABLE 15

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-Capraearum*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
36	<i>Salix Bakko</i>	May 17, 1926	May 28
37	<i>S. Miyabeana</i>	May 17, 1926	—
38	<i>S. rorida</i>	May 17, 1926	—
39	<i>S. viminalis</i> var. <i>yezoensis</i>	May 17, 1926	—

**Remarks.** In 1919, MATSUMOTO (12) reported that a *Melampsora* on *Salix Bakko* collected by him in the vicinity of Sapporo seems to have no aecidial stage either on needles of *Larix* or on *Abies*.

### 3. *Melampsora Larici-Urbani* MATSUMOTO

*Experiments I and II.* On November 3 and 18, 1925, on the river bank of the Toyohira near Sapporo, the writer collected teleutospores of this species on *Salix Urbani* for inoculations. On April 23, the next spring, the sporidia from materials collected on November 3, and 5 days after the sporidia from those collected on November 18, were sown on the needles of *Larix Kaempferi*. The results of these experiments are positive as in the following table.



TABLE 16

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-Urbani*ana on *Salix Urbaniana*—1.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
40	<i>Larix Kaempferi</i>	April 23, 1926	May 3	May 7 *
41	<i>Larix Kaempferi</i>	April 28, 1926	May 8	May 11 **

(\* Experiment I, \*\* Experiment II)

*Experiment III.* The writer also obtained positive results with the aecidiospores from Experiment II on the leaves of *Salix Urbaniana*, shown as in the following table.

TABLE 17

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-Urbani*ana.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of uredosori
42	<i>Salix Urbaniana</i>	May 14, 1926	May 24

*Experiment IV.* The teleutospores of this species parasitic on *Salix Urbaniana* which had been collected at the foot of Mt. Daisen, province of Hôki on November 8, 1930, were used as the inoculating materials.

In April of the next year, inoculations were made on seedlings of *Abies Mayriana* and *Larix Kaempferi*, and the results are given in the following table.

TABLE 18

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-Urbani*ana on *Salix Urbaniana*—2.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
43	<i>Larix Kaempferi</i>	April 1, 1931	April 15	April 18
44	<i>Abies Mayriana</i>	April 1, 1931	—	—

*Experiment V.* On April 30, 1931, the return inoculations with the aecidiospores obtained from Experiment IV were carried on. Nine days after sowing of the aecidiospores numerous uredosori appeared on the inoculated leaves of *Salix Urbaniana*.

#### 4. *Melampsora Larici-populina* KLEB.

*Experiment I.* The writer collected the teleutospores on leaves of *Populus nigra* L. var. *italica* Du Roi along the river bank of the Toyohira on November 11, 1924, and on May 15 the next spring he inoculated on needles of *Larix Kaempferi* with the sporidia from those teleutospores. Eleven days after inoculation, spermogonia began to appear, and six days later caeomata appeared. (*Experiment No. 45*)

*Experiments II and III.* In November 1925, the teleutospores on *Populus nigra* var. *italica* and *P. Maximowiczii* were collected at the same place, and inoculations were made with the sporidia from the above two different plants on needles of *Larix Kaempferi* in the next spring. The results of these experiments are given in the following tables.

TABLE 19

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-populina* on *Populus nigra* var. *italica*.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
46	<i>Larix Kaempferi</i>	April 25, 1926	May 4	May 8

TABLE 20

Showing the results of the inoculation experiments with the sporidia of *Melampsora Larici-populina* on *Populus Maximowiczii*.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
47	<i>Larix Kaempferi</i>	April 28, 1926	May 7	May 12

*Experiment IV.* In this series, attempts were made to inoculate the aecidiospores on *Larix Kaempferi* which had been obtained from the teleutospores on *Populus nigra* var. *italica* in Experiment II, on the leaves of *Salix Miyabeana*, *S. sachalinensis*, *S. viminalis* var. *yezoensis*, *Populus Maximowiczii* and *P. nigra* var. *italica*. The results are as follows :

TABLE 21

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-populina*-1.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
48	<i>Salix Miyabeana</i>	May 9, 1926	—
49	<i>S. sachalinensis</i>	May 9, 1926	—
50	<i>S. viminalis</i> var. <i>yezoensis</i>	May 9, 1926	—
51	<i>Populus Maximowiczii</i>	May 9, 1926	May 20
52	<i>P. nigra</i> var. <i>italica</i>	May 9, 1926	May 20

As shown in the preceding table, uredosori occurred only on the two species of *Populus*, while no sign on the three species of *Salix* appeared.

*Experiment V.* In this experiment, inoculations were made with the aecidiospores from *Populus Maximowiczii* (*Experiment III*) on three species of *Salix* and two of *Populus* as in the former series. The results are shown in the following table.

TABLE 22

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora Larici-populina*-2.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
53	<i>Salix Miyabeana</i>	May 8, 1926	—
54	<i>S. sachalinensis</i>	May 8, 1926	—
55	<i>S. viminalis</i> var. <i>yezoensis</i>	May 8, 1926	—
56	<i>Populus Maximowiczii</i>	May 8, 1926	May 19
57	<i>P. nigra</i> var. <i>italica</i>	May 8, 1926	May 18



As shown in this table, the same results were obtained as in Experiment IV.

### 5. *Melampsora Magnusiana* G. WAGNER

The teleutospores of *Melampsora Magnusiana* on leaves of *Populus Sieboldi* Miq. were collected from the foot of Mt. Moiwa near Sapporo on November 3, 1925, and the sporidia were inoculated on leaves of *Abies Mayriana*, *Chelidonium majus* and *Larix Kaempferi* on May 16 of the next year. The results of these experiments are given in Table 23.

TABLE 23

Showing the results of the inoculation experiments with the sporidia of *Melampsora Magnusiana* on *Populus Sieboldi*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of caeomata
58	<i>Abies Mayriana</i>	May 16, 1926	—	—
59	<i>Chelidonium majus</i>	May 16, 1926	May 23	May 27
60	<i>Larix Kaempferi</i>	May 16, 1926	—	—

As indicated above, on the leaves of *Chelidonium majus*, spermogonia appeared on May 23 and aecidia four days later, but no sign of spermogonia nor aecidia appeared on the other two plants.

No return inoculation with the aecidiospores has been made by the writer.

### 6. *Melampsora yezoensis* MIYABE et MATSUMOTO

The writer attempted to inoculate with aecidiospores of the present species on *Corydalis ambigua* which had been found at Maruyama near Sapporo May 2, 1927, on *Salix Urbaniana*, *S. jessoensis*, *S. rorida* and *S. sachalinensis*. Positive results were readily secured on *Salix jessoensis*, while on the other three species of *Salix* inoculations were unsuccessful, as shown in the following table.

TABLE 24

Showing the results of the inoculation experiments with the aecidiospores of *Melampsora yezoensis*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
61	<i>Salix Urbaniana</i>	May 2, 1927	—
62	<i>S. jessoensis</i>	May 2, 1927	May 11
63	<i>S. rorida</i>	May 2, 1927	—
64	<i>S. sachalinensis</i>	May 2, 1927	—

No return inoculation experiment with the sporidia of the present fungus has been made by the writer.

#### 7. *Melampsorium Alni* (THÜM.) DIET.

*Experiment I.* A large number of the teleutospores on *Alnus Maximowiczii* CALL. were collected on the river bank of the Toyohira near Sapporo November 13, 1924, and the sporidia from those teleutospores were inoculated on needles of *Abies Mayriana* and *Larix Kaempferi* on April 30 of the next spring. The results of this experiment are tabulated as follows :

TABLE 25

Showing the results of the inoculation experiments with the sporidia of *Melampsorium Alni* on *Alnus Maximowiczii*—1.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
65	<i>Larix Kaempferi</i>	April 30, 1925	May 10	May 17
66	<i>Abies Mayriana</i>	April 30, 1925	—	—

As shown in the preceding table, leaves of *Larix Kaempferi* were infected and both spermogonia and peridermia were produced, while on leaves of *Abies Mayriana* no sign of spermogonia nor peridermia appeared.

*Experiment II.* In the spring of 1926, the same experiments were repeated with the teleuto-materials on the same plant collected at Zenibako, province of Shiribeshi on December 5, 1925. The results of the experiment are shown in the following table.

TABLE 26

Showing the results of the inoculation experiments with the sporidia of *Melampsoridium Alni* on *Alnus Maximowiczii*—2.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
67	<i>Larix Kaempferi</i>	April 25, 1926	May 4	May 12
68	<i>Abies Mayriana</i>	April 25, 1926	—	—

As shown in the above table, the same results were obtained as in Experiment I.

*Experiment III.* In May of 1927, the writer inoculated with the sporidia from teleutospores on *Alnus Maximowiczii* which had been collected at the College farm of the Faculty of Agriculture (Sapporo) on October 4, 1926, on needles of three species of *Larix*; *Larix Kaempferi*, *L. europaea* DC. and *L. dahurica* TURCZ. var. *japonica* MAXIM., and got the successful results showing in the following table.

TABLE 27

Showing the results of the inoculation experiments with the sporidia of *Melampsoridium Alni* on *Alnus Maximowiczii*—3.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
69	<i>Larix dahurica</i> var. <i>japonica</i>	May 2, 1927	May 14	May 20
70	<i>L. europaea</i>	May 2, 1927	May 12	May 18
71	<i>L. Kaempferi</i>	May 2, 1927	May 14	May 22

*Experiment IV.* In this series, the aecidiospores forming on *Larix Kaempferi* from Experiment II, were transferred onto leaves of seedlings of *Alnus Maximowiczii* and *A. hirsuta* TURCZ. The results are given as follows:



TABLE 28

Showing the results of the inoculation experiments with the aecidiospores of *Melampsoridium Alni*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
72	<i>Alnus hirsuta</i>	May 23, 1927	—
73	<i>A. Maximowiczii</i>	May 23, 1927	May 30

Eight days after inoculation, uredosori came out on the inoculated leaves of *Alnus Maximowiczii*, while no sign on *Alnus hirsuta* appeared.

*Experiment V.* The sporidia from teleutospores of this species on leaves of *Alnus pendula* MATSUM. collected at Zenibako-tôge, province of Shiribeshi on October 10, 1926, were inoculated on needles of *Larix Kaempferi* on May 2 of the next year, and positive results were obtained as follows :

TABLE 29

Showing the results of the inoculation experiments with the sporidia of *Melampsoridium Alni* on *Alnus pendula*-1.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
74	<i>Larix Kaempferi</i>	May 2, 1927	May 11	May 16

*Experiment VI.* In this experiment, inoculations with the sporidia from teleutospores on *Alnus pendula* collected at the foot of Mt. Daisen, province of Hôki on November 9, 1930 were made on seedlings of *Larix Kaempferi*. The results are shown in the following table.

TABLE 30

Showing the results of the inoculation experiments with the sporidia of *Melampsoridium Alni* on *Alnus pendula*-2.

Experiment No.	Plant inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
75	<i>Larix Kaempferi</i>	April 30, 1931	May 13	May 19

**Remarks.** From these experiments, it is evidently determined that the present species is heteroecious and must its aecidial stage occur on *Larix* sps. The aecidial stage of this species obtained from the experiments may be described as follows :

Spermogonia amphigenous, mostly hypophyllous, subcuticular, minute, lenticular form,  $90-126 \times 30-55 \mu$ , honey-yellow; spermatia oblong,  $5-9 \times 2.4-4.2 \mu$ , smooth, hyaline. Peridermia hypophyllous, cylindrical, 0.5–2 mm. across, up to 1.4 mm. high; peridial wall colourless, cells quadrilateral or hexagonal in face view,  $23.4-36 \times 14.4-20 \mu$ , overlapping, inner wall thick, closely verrucose with uniform papillae; aecidiospores ellipsoidal,  $19-26.1 \times 15-20 \mu$ ; epispore verruculose,  $1.8-2.5 \mu$  thick, with a smooth area on some spores, hyaline; contents orange coloured when the spores are fresh.

In 1926, N. LAVROV (10) described a Peridermium on *Larix sibirica* LEDEB. collected by W. REWERDATTO at Plachino along the Yenisei river, Siberia, as a new species, *Peridermium Krylowianum*. Although the writer has not been able to examine its authentic specimen for comparison, it seems to be the aecidial stage of this species or *Melampsoridium Hiratsukanum*.

### 8. *Melampsoridium Hiratsukanum* ITO

*Experiment I.* The well-developed teleutospores of the present species on *Alnus hirsuta* were collected at Sapporo on December 2, 1924 for inoculation. On May 2 of the next year, attempts were made to inoculate sporidia from the teleutospores on needles of *Abies Mayriana* and *Larix Kaempferi*. The results are given in the following table.

TABLE 31

Showing the results of the inoculation experiments with the sporidia of *Melampsoridium Hiratsukanum* on *Alnus hirsuta*—1.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
76	<i>Abies Mayriana</i>	May 2, 1925	—	—
77	<i>Larix Kaempferi</i>	May 2, 1925	May 12	May 21

*Experiment II.* In this experiment, inoculations with sporidia from the teleutospores on *Alnus hirsuta* which had been collected at the foot of Mt. Moiwa near Sapporo November 15, 1925 were made on *Abies Mayriana* and *Larix Kaempferi*. As shown in the following table, the same results were obtained as in Experiment I.

TABLE 32

Showing the results of the inoculation experiments with the sporidia of *Melampsoridium Hiratsukanum* on *Alnus hirsuta*—2.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
78	<i>Abies Mayriana</i>	April 25, 1926	—	—
79	<i>Larix Kaempferi</i>	April 25, 1926	May 4	May 14

*Experiment III.* This experiment was carried out in order to determine the return infection with the aecidiospores on species of *Alnus*. The aecidiospores from Experiment II were used as inoculum. The results of the experiment are given in the following table.

TABLE 33

Showing the results of the inoculation experiments with the aecidiospores of *Melampsoridium Hiratsukanum*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
80	<i>Alnus hirsuta</i>	May 17, 1926	May 25
81	<i>A. hirsuta</i> var. <i>sibirica</i>	May 17, 1926	May 24
82	<i>A. Maximowiczii</i>	May 17, 1926	—

*Experiment IV.* On June 29, 1926, the writer found numerous peridermia occurring on needles of *Larix Kaempferi* growing in the botanic garden of the Hokkaido Imperial University. Inoculations with those aecidiospores were made on *Alnus hirsuta* and *A. Maximowiczii* on the same day. The results are as follows:



TABLE 34

Showing the results of the inoculation experiments with the aecidiospores from peridermia on *Larix Kaempferi*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
83	<i>Alnus hirsuta</i>	June 29, 1926	June 7
84	<i>A. Maximowiczii</i>	June 29, 1926	—

As shown in the table, positive results were readily secured on the leaves of *Alnus hirsuta*, while on another species inoculations were unsuccessful. From the inoculation experiments and the characters of the uredostage produced on *Alnus hirsuta* by cultures, it is evidently determined that a peridermial stage on *Larix Kaempferi* is that of *Melampsoridium Hiratsukanum*.

*Experiment V.* In May 1927, inoculations with sporidia from the teleutospores on *Alnus hirsuta* collected at Maruyama near Sapporo October 20, 1926, were made on *Larix dahurica* var. *japonica*, *L. europaea* and *L. Kaempferi*, and positive results were gotten as shown in the following table.

TABLE 35

Showing the results of the inoculation experiments with the sporidia of *Melampsoridium Hiratsukanum* on *Alnus hirsuta*—3.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
85	<i>Larix dahurica</i> var. <i>japonica</i>	May 3, 1927	May 16	May 22
86	<i>L. europaea</i>	May 3, 1927	May 14	May 20
87	<i>L. Kaempferi</i>	May 3, 1927	May 15	May 22

*Remarks.* The essential characters of the aecidial stage of the present species agree with those of *Melampsoridium Alni*.

### 9. *Melampsorella Caryophyllacearum* SCHRÖT.

On July 28, 1927, the writer inoculated with the aecidiospores of the present species on needles of *Abies Mayriana* collected at Nopporo, province of Ishikari on leaves of *Cerastium vulgatum* L. var. *glandulosum* RGL., and nine days after sowing of the aecidiospores numerous uredosori appeared on the inoculated surface of the leaves of *Cerastium*. (*Experiment No. 88*) No return inoculation with the sporidia has been made by the writer.

### 10. *Pucciniastrum Miyabeae* HIRATS.

*Experiment I.* The teleutospores on *Viburnum furcatum* BL. which were collected at the foot of Mt. Daisen, province of Hôki on November 9, 1930 were used as an inoculum. On April 2 of the next year, sporidia from the teleutospores were sown on needles of *Abies Mayriana*, *Larix Kaempferi*, *Picea jezoensis*, *Pinus densiflora* and leaves of *Chelidonium majus*. Positive results were readily secured on the needles of *Abies Mayriana*, as shown in Table 36, while on the remaining plants inoculations were unsuccessful.

TABLE 36

Showing the results of the inoculation experiments with the sporidia of *Pucciniastrum Miyabeae* on *Viburnum furcatum*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
89	<i>Abies Mayriana</i>	April 2, 1931	April 15	April 22
90	<i>Chelidonium majus</i>	April 2, 1931	—	—
91	<i>Picea jezoensis</i>	April 2, 1931	—	—
92	<i>Pinus densiflora</i>	April 2, 1931	—	—
93	<i>Larix Kaempferi</i>	April 2, 1931	—	—

*Experiment II.* To determine the return infection, the following experiments with the aecidiospores were conducted. In May 1931, the aecidiospores which had been produced on the needles of *Abies May-*

*riana* were sown on leaves of *Clethra barbinervis* SIEB. et ZUCC., *Styrax japonica* SIEB. et ZUCC. and *Viburnum furcatum*. The results are given in the following table.

TABLE 37

Showing the results of the inoculation experiments with the aecidiospores of *Pucciniastrum Miyabeaeum*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
94	<i>Viburnum furcatum</i>	May 2, 1931	May 15
95	<i>Styrax japonica</i>	May 2, 1931	—
96	<i>Clethra barbinervis</i>	May 2, 1931	—

As shown in the above table, positive results were secured on *Viburnum furcatum*, while on the remaining plants inoculations were unsuccessful.

**Remarks.** From the experiments, it is evidently established that *Pucciniastrum Miyabeaeum* on *Viburnum furcatum* collected at the foot of Mt. Daisen is heteroecious and must have its aecidial stage on *Abies* sps.

The aecidial stage resulting from these experiments may be described as follows: Spermogonia mostly epiphyllous, subcuticular, hemispherical, flattened,  $112-156\mu$  across,  $42-66\mu$  high, honey-yellow; spermatia globose, ellipsoidal to oblong,  $2.8-6 \times 1.2-2.5\mu$ , hyaline, smooth. Peridermia hypophyllous, cylindrical,  $0.8-1.6$  mm. high,  $0.25-0.35$  mm. across; peridial wall hyaline, cells rhomboid or elongated hexagonal, overlapping,  $42-63 \times 15-21\mu$ , inner wall thick, verrucose; aecidiospores globose, subglobose or ellipsoidal,  $18-27 \times 15-18\mu$ ; epispore ca.  $2\mu$ , hyaline, finely echinulate; contents yellow in colour.

### 11. *Pucciniastrum Epilobii* OTTH

The sporidia from teleutospores of this fungus on *Epilobium angustifolium* L. which had been collected at the foot of Mt. Teine, province of Ishikari on November 24, 1925, were suspended above the needles of

*Abies Mayriana*, *Larix Kaempferi* and *Picea jezoensis* on May 21 of the next year. The results are given in the following table.

TABLE 38

Showing the results of the inoculation experiments with the sporidia of *Pucciniastrum Epilobii* on *Epilobium angustifolium*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of spermogonia	Date of appearance of peridermia
97	<i>Abies Mayriana</i>	May 21, 1926	June 3	June 8
98	<i>Larix Kaempferi</i>	May 21, 1926	—	—
99	<i>Picea jezoensis</i>	May 21, 1926	—	—

On a number of the inoculated leaves of *Abies Mayriana*, spermogonia produced on June 3, and peridermia began to appear on June 8. The peridermia developed rapidly and were mature in a few days. No return inoculations with the aecidiospores were made.

## 12. *Cronartium flaccidum* (ALB. et SCHW.) WINT.

The writer obtained the aecidiospores of the present species occurring on branches of *Pinus densiflora* at Sapporo on June 8, 1924, and inoculations were made with the aecidiospores on leaves of *Paeonia albiflora* PALL., *P. Moutan* SIM. and *P. obovata* MAXIM. var. *typica* MAK. On all plants, successful results were obtained as shown in the following table.

TABLE 39

Showing the results of the inoculation experiments with the aecidiospores of *Cronartium flaccidum*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
100	<i>Paeonia albiflora</i>	June 8, 1924	June 16
101	<i>P. Moutan</i>	June 8, 1924	June 7
102	<i>P. obovata</i> var. <i>typica</i>	June 8, 1924	June 17



13. *Cronartium Quercuum* MIYABE

*Experiment I.* On May 20, 1927, a gall with matured peridermia of the present fungus on *Pinus densiflora* was collected at Maruyama near Sapporo. On the next morning, inoculation experiments were made with the aecidiospores on the under surface of *Quercus crispula* BL., *Q. dentata* THUNB., *Q. mongolica* FISCH., *Q. rubra* L. and *Q. serrata* in the arboretum belonging to the Department of Forestry, Hokkaido Imperial University. On May 29, numerous uredosori appeared on the inoculated surface of *Quercus crispula*, *Q. serrata* and *Q. mongolica*, and three days later on *Quercus dentata* and *Q. rubra*.

TABLE 40

Showing the results of the inoculation experiments with the aecidiospores of *Cronartium Quercuum* on *Pinus densiflora*.

Experiment No.	Plants inoculated	Date of inoculation	Date of appearance of uredosori
103	<i>Quercus crispula</i>	May 21, 1927	May 29
104	<i>Q. dentata</i>	May 21, 1927	June 1
105	<i>Q. mongolica</i>	May 21, 1927	May 29
106	<i>Q. rubra</i>	May 21, 1927	June 1
107	<i>Q. serrata</i>	May 21, 1927	May 29

*Experiment II. (Experiments No. 108-113)* In this experiment, inoculations were tried with the aecidiospores from a richly sporulating gall found on *Pinus densiflora* which had been collected at Manisan near Tottori on May 8, 1929, on leaves of *Quercus acuta* THUNB., *Q. acutissima*, *Q. serrata*, *Q. variabilis*, *Castanea Bungeana* BL. and *Pasania Sieboldi* MAK. in the botanic garden of Tottori Agricultural College. Infection followed with a marked development of uredosori on *Quercus acutissima*, *Q. serrata* and *Q. variabilis*, and slight infection appeared on *Castanea Bungeana* and *Pasania Sieboldi* with sparing development of sori, while on *Quercus acuta* inoculations were unsuccessful.

*Experiment III. (Experiments No. 114-125)* In this series, the aecidiospores on *Pinus densiflora* collected from Omokage-mura near

Tottori were used as an inoculum. They were inoculated on leaves of the following species of the family Fagaceae, viz. *Quercus acuta*, *Q. acutissima*, *Q. crispula*, *Q. dentata*, *Q. glauca* THUNB., *Q. myrsinaefolia* BL., *Q. rubra*, *Q. serrata*, *Q. variabilis*, *Castanea Bungeana*, *Fagus crenata* BL. and *Pasania Sieboldi* in the botanic garden of the College on both April 25 and May 7, 1931.

About ten to fourteen days after sowing of the aecidiospores, uredosori began to appear on the inoculated leaves of *Quercus crispula*, *Q. dentata*, *Q. rubra* and *Q. serrata*, and uredosori developed abundantly. Positive results were also obtained on *Quercus acutissima*, *Q. glauca*, *Q. myrsinaefolia*, *Q. variabilis*, *Castanea Bungeana* and *Pasania Sieboldi*, but uredosori were produced slightly. On *Fagus crenata*, mycelia developed abundantly in the intercellular space of the tissues, but uredosori were not produced until a month after inoculation. No sign of infection appeared on *Quercus acuta*.

**Remarks.** From the preceding results, one may judge that the aecidiospores of the present fungus are not only able to infect on *Quercus serrata*, *Q. acutissima* and *Q. variabilis*, but also on the following species, *Castanea Bungeana*, *Pasania Sieboldi*, *Quercus dentata*, *Q. crispula*, *Q. glauca*, *Q. mongolica*, *Q. myrsinaefolia* and *Q. rubra*.

### Conclusive summary

A summary of the preceding data is given in the following table.

TABLE 41

Summary of the results of the inoculation experiments

Species	Materials inoculated	Experiment No.	Plants inoculated	Results
<i>Melampsora Larici-epitea</i>	Sporidia on <i>Salix viminalis</i> var. <i>yezoensis</i>	1, 2	<i>Larix Kaempferi</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 2)	3	<i>Salix Bakko</i>	—
		4	<i>S. Miyabeana</i>	—
		5	<i>S. rorida</i>	—
		6	<i>S. viminalis</i> var. <i>yezoensis</i>	+
		7	<i>Populus Maximowiczii</i>	—

TABLE 41 (Continued)

Species	Materials inoculated	Experiment No.	Plants inoculated	Results
<i>Melampsora Larici-epitea</i>	Sporidia on <i>Salix rorida</i>	8	<i>Larix Kaempferi</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 8)	9	<i>Salix Bakko</i>	—
		10	<i>S. jessoensis</i>	—
		11	<i>S. Miyabeana</i>	—
		12	<i>S. rorida</i>	+
		13	<i>S. sachalinensis</i>	—
	Sporidia on <i>Salix Miyabeana</i>	14, 15	<i>Larix Kaempferi</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 15)	16	<i>Salix Bakko</i>	—
		17	<i>S. jessoensis</i>	—
		18	<i>S. Miyabeana</i>	+
		19	<i>S. rorida</i>	+
		20	<i>S. sachalinensis</i>	—
	Sporidia on <i>Salix sachalinensis</i>	21, 22, 25	<i>Larix Kaempferi</i>	+
		23	<i>Abies Mayriana</i>	—
		24	<i>Chelidonium majus</i>	—
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 22, 25)	26, 31	<i>Salix Bakko</i>	—
		32	<i>S. daiseniense</i>	—
		27	<i>S. jessoensis</i>	—
		28	<i>S. Miyabeana</i>	—
		29	<i>S. rorida</i>	—
		30, 33	<i>S. sachalinensis</i>	+
		34	<i>S. viminalis</i> var. <i>yezoensis</i>	—
<i>Melampsora Larici-Capraearum</i>	Sporidia on <i>Salix Bakko</i>	35	<i>Larix Kaempferi</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 35)	36	<i>Salix Bakko</i>	+
		37	<i>S. Miyabeana</i>	—
		38	<i>S. rorida</i>	—
		39	<i>S. viminalis</i> var. <i>yezoensis</i>	—
<i>Melampsora Larici-Urbaniiana</i>	Sporidia on <i>Salix Urbaniiana</i>	40, 41, 43 44	<i>Larix Kaempferi</i> <i>Abies Mayriana</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 41)	42	<i>Salix Urbaniiana</i>	+

TABLE 41 (Continued)

Species	Materials inoculated	Experiment No.	Plants inoculated	Results
<i>Melampsora Larici-populina</i>	Sporidia on <i>Populus nigra</i> var. <i>italica</i>	45, 46	<i>Larix Kaempferi</i>	+
	Sporidia on <i>Populus Maximowiczii</i>	47	<i>Larix Kaempferi</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 46)	48	<i>Salix Miyabeana</i>	—
		49	<i>S. sachalinensis</i>	—
		50	<i>S. viminalis</i> var. <i>yezoensis</i>	—
		51	<i>Populus Maximowiczii</i>	+
		52	<i>P. nigra</i> var. <i>italica</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 47)	53	<i>Salix Miyabeana</i>	—
		54	<i>S. sachalinensis</i>	—
		55	<i>S. viminalis</i> var. <i>yezoensis</i>	—
		56	<i>Populus Maximowiczii</i>	+
		57	<i>P. nigra</i> var. <i>italica</i>	+
<i>Melampsora Magnusiana</i>	Sporidia on <i>Populus Sieboldi</i>	58	<i>Abies Mayriana</i>	—
		59	<i>Chelidonium majus</i>	+
		60	<i>Larix Kaempferi</i>	—
<i>Melampsora yezoensis</i>	Aecidiospores on <i>Corydalis ambigua</i>	61	<i>Salix Urbaniana</i>	—
		62	<i>S. jessoensis</i>	+
		63	<i>S. rorida</i>	—
		64	<i>S. sachalinensis</i>	—
<i>Melampori-dium Alni</i>	Sporidia on <i>Alnus Maximowiczii</i>	66, 68	<i>Abies Mayriana</i>	—
		69	<i>Larix dahurica</i> var. <i>japonica</i>	+
		65, 67, 71	<i>L. Kaempferi</i>	+
		70	<i>L. europaea</i>	+
	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 67)	72	<i>Alnus hirsuta</i>	—
		73	<i>A. Maximowiczii</i>	+
	Sporidia on <i>Alnus pendula</i>	74, 75	<i>Larix Kaempferi</i>	+
<i>Melampori-dium Hira-tsukanum</i>	Sporidia on <i>Alnus hirsuta</i>	76, 78	<i>Abies Mayriana</i>	—
		85	<i>Larix dahurica</i> var. <i>japonica</i>	+
		86	<i>L. europaea</i>	+
		77, 79, 87	<i>L. Kaempferi</i>	+



TABLE 41 (Continued)

Species	Materials inoculated	Experiment No.	Plants inoculated	Results
<i>Melampsorium Hirsukanum</i>	Aecidiospores on <i>Larix Kaempferi</i> (Exp. No. 79)	80, 83	<i>Alnus hirsuta</i>	+
		81	<i>A. hirsuta</i> var. <i>sibirica</i>	+
		82, 84	<i>A. Maximowiczii</i>	—
<i>Melampsorella Caryophyllacearum</i>	Aecidiospores on <i>Abies Mayriana</i>	88	<i>Cerastium vulgatum</i> var. <i>glandulosum</i>	+
<i>Pucciniastrum Miyabeaenum</i>	Sporidia on <i>Viburnum furcatum</i>	89	<i>Abies Mayriana</i>	+
		90	<i>Chelidonium majus</i>	—
		91	<i>Picea jezoensis</i>	—
		92	<i>Pinus densiflora</i>	—
		93	<i>Larix Kaempferi</i>	—
	Aecidiospores on <i>Abies Mayriana</i> (Exp. No. 89)	96	<i>Clethra barbinervis</i>	—
		95	<i>Styrax japonica</i>	—
		94	<i>Viburnum furcatum</i>	+
	Sporidia on <i>Epilobium angustifolium</i>	97	<i>Abies Mayriana</i>	+
		98	<i>Larix Kaempferi</i>	—
		99	<i>Picea jezoensis</i>	—
<i>Cronartium flaccidum</i>	Aecidiospores on <i>Pinus densiflora</i>	100	<i>Paeonia albiflora</i>	+
		101	<i>P. Moutan</i>	+
		102	<i>P. obovata</i> var. <i>typica</i>	+
<i>Cronartium Quercuum</i>	Aecidiospores on <i>Pinus densiflora</i>	108, 114	<i>Quercus acuta</i>	—
		109, 115	<i>Q. acutissima</i>	+
		103, 116	<i>Q. crispula</i>	+
		104, 117	<i>Q. dentata</i>	+
		118	<i>Q. glauca</i>	+
		105	<i>Q. mongolica</i>	+
		119	<i>Q. myrsinaefolia</i>	+
		106, 120	<i>Q. rubra</i>	+
		107, 110, 121	<i>Q. serrata</i>	+
		111, 122	<i>Q. variabilis</i>	+
		112, 123	<i>Castanea Bungeana</i>	+
		124	<i>Fagus crenata</i>	—
		113, 125	<i>Pasania Sieboldi</i>	+

Positive results marked +, negative results —.

The positive results obtained by the inoculation experiments with Japanese species belonging to the Melampsoraceae already reported, may be summarized in the following table.

TABLE 42

Summary of the results of the inoculation experiments with heteroecious species of the *Melampsoraceae* in Japan

Species	Investigator	Year investigated	Host plant of aecidial stage	Host plant of uredo- and teleutostage
<i>Melampsora yezoensis</i>	MATSUMOTO	1915 (Sapporo)	<i>Corydalis ambigua</i>	<i>Salix jessoensis</i>
	HIRATSUKA	1927 (Sapporo)	<i>Corydalis ambigua</i>	<i>Salix jessoensis</i>
<i>Melampsora Larici-epitea</i>	MATSUMOTO	1915 (Sapporo)	<i>Larix europaea</i> <i>L. Kaempferi</i>	<i>Salix viminalis</i> var. <i>yezoensis</i>
	HIRATSUKA	1925 (Sapporo) 1926 (Sapporo)	<i>Larix Kaempferi</i>	<i>Salix viminalis</i> var. <i>yezoensis</i>
	MATSUMOTO	1915 (Sapporo)	<i>Larix europaea</i> <i>L. Kaempferi</i>	<i>Salix Miyabeana</i>
	HIRATSUKA	1925 (Sapporo) 1926 (Sapporo)	<i>Larix Kaempferi</i>	<i>Salix Miyabeana</i>
	MATSUMOTO	1915 (Sapporo)	<i>Larix europaea</i> <i>L. Kaempferi</i>	<i>Salix rorida</i>
	HIRATSUKA	1926 (Sapporo)	<i>Larix Kaempferi</i>	<i>Salix rorida</i>
	MATSUMOTO	1915 (Sapporo)	<i>Larix europaea</i> <i>L. Kaempferi</i>	<i>Salix sachalinensis</i>
	HIRATSUKA	1925 (Sapporo) 1926 (Sapporo) 1931 (Tottori)	<i>Larix Kaempferi</i>	<i>Salix sachalinensis</i>
	MATSUMOTO	1916 (Sapporo)	<i>Larix europaea</i>	<i>Salix Urbaniana</i>
	HIRATSUKA	1926 (Sapporo) 1931 (Tottori)	<i>Larix Kaempferi</i>	<i>Salix Urbaniana</i>

TABLE 42 (Continued)

Species	Investigator	Year investigated	Host plant of aecidial stage	Host plant of uredo- and teleutostage
<i>Melampsora Larici-Capraearum</i>	HIRATSUKA	1926 (Sapporo)	<i>Larix Kaempferi</i>	<i>Salix Bakko</i>
<i>Melampsora Chelidonii-Pierotii</i>	MATSUMOTO	1924 (Morioka)	<i>Chelidonium majus</i> <i>Corydalis incisa</i>	<i>Salix Pierotii</i>
<i>Melampsora Larici-populina</i>	MATSUMOTO	1916 (Sapporo)	<i>Larix europaea</i> <i>L. Kaempferi</i>	<i>Populus Maximo-wiczii</i>
	HIRATSUKA	1925 (Sapporo) 1926 (Sapporo)	<i>Larix Kaempferi</i>	<i>Populus Maximo-wiczii</i> <i>P. nigra</i> var. <i>italica</i>
<i>Melampsora Magnusiana</i>	HIRATSUKA	1925 (Sapporo)	<i>Chelidonium majus</i>	<i>Populus Sieboldi</i>
<i>Melampsorella Caryophyllacearum</i>	HIRATSUKA	1927 (Sapporo)	<i>Abies Mayriana</i>	<i>Cerastium vulgatum</i> var. <i>glandulosum</i>
<i>Melampsorium Alni</i>	HIRATSUKA	1925 (Sapporo) 1926 (Sapporo) 1927 (Sapporo) 1931 (Tottori)	<i>Larix dahurica</i> var. <i>japonica</i> <i>L. europaea</i> <i>L. Kaempferi</i>	<i>Alnus Maximo-wiczii</i> <i>A. pendula</i>
<i>Melampsorium Hiratsukanum</i>	HIRATSUKA	1925 (Sapporo) 1926 (Sapporo)	<i>Larix dahurica</i> var. <i>japonica</i> <i>L. europaea</i> <i>L. Kaempferi</i>	<i>Alnus hirsuta</i> <i>A. hirsuta</i> var. <i>sibirica</i>
<i>Pucciniastrum Miyabeaenum</i>	HIRATSUKA	1931 (Tottori)	<i>Abies Mayriana</i>	<i>Viburnum furcatum</i>
<i>Pucciniastrum Epilobii</i>	HIRATSUKA	1926 (Sapporo)	<i>Abies Mayriana</i>	<i>Epilobium angustifolium</i>
<i>Milesina vogesiaca</i>	KAMEI	1924 (Sapporo) 1925 (Sapporo) 1926 (Sapporo) 1928 (Sapporo) 1929 (Sapporo)	<i>Abies firma</i> <i>A. Mayriana</i> <i>A. sachalinensis</i>	<i>Polystichum Braunii</i>

TABLE 42 (Continued)

Species	Investigator	Year investigated	Host plant of aecidial stage	Host plant of uredo- and teleutostage
<i>Uredinopsis Pteridis</i>	KAMEI	1923 (Sapporo) 1924 (Sapporo) 1925 (Sapporo) 1927 (Sapporo) 1928 (Sapporo)	<i>Abies Mayriana</i>	<i>Pteridium aquilinum</i> var. <i>japonicum</i>
<i>Chrysomyxa expansa</i>	MIYABE	1913 (Sapporo)	<i>Picea jezoensis</i>	<i>Rhododendron Fauriae</i> var. <i>rufescens</i>
<i>Cronartium flaccidum</i>	MIYABE & ITO	1913 (?) (Sapporo)	<i>Pinus densiflora</i>	<i>Paeonia albiflora</i>
	HIRATSUKA	1924 (Sapporo)	<i>Pinus densiflora</i>	<i>Paeonia albiflora</i> <i>P. Moutan</i> <i>P. obovata</i> var. <i>typica</i>
<i>Cronartium Quercuum</i>	SHIRAI	1897 (Tokyo) 1898 (Tokyo)	<i>Pinus densiflora</i>	<i>Quercus acutissima</i> <i>Q. variabilis</i> <i>Q. serrata</i>
	HIRATSUKA	1927 (Sapporo)	<i>Pinus densiflora</i>	<i>Quercus crispula</i> <i>Q. serrata</i> <i>Q. mongolica</i> <i>Q. dentata</i> <i>Q. rubra</i>
	HIRATSUKA & YOSHIDA	1930 (Tottori) 1931 (Tottori)	<i>Pinus densiflora</i>	<i>Castanea Bungeana</i> <i>Pasania Sieboldi</i> <i>Q. acutissima</i> <i>Q. variabilis</i> <i>Q. serrata</i> <i>Q. dentata</i> <i>Q. glauca</i> <i>Q. rubra</i> <i>Q. myrsinaefolia</i>



## Literature cited

1. HIRATSUKA, NAOHIDE—Notes on Japanese species of *Melampsoridium* KLEB. (Jour. Soc. Agric. & Forestr. Sapporo, XVIII, p. 78-90, 1926). In Japanese.
2. HIRATSUKA, NAOHIDE—Notes on Japanese species of *Melampsora* parasitic on species of *Larix*. (Ibid. XIX, p. 180-194, 1927). In Japanese.
3. HIRATSUKA, NAOHIDE—Beiträge zu einer Monographie der Gattung *Pucciniastrum* OTTH. (Jour. Facul. Agric. Hokkaido Imp. Univ. XXI, p. 63-120, 1 Taf., 1927).
4. HIRATSUKA, NAOHIDE—Notes on witches-broom of fir in Japan. (Agriculture & Horticulture, V, p. 153-164, 1930). In Japanese.
5. HIRATSUKA, NAOHIDE—On the mutual relation and phylogeny of the species belonging to the subfamily Pucciniastreae. (Jour. Soc. Agric. & Forestr. Sapporo, XXII, p. 22-39, 1930). In Japanese.
6. ITO, S.—On the rust disease of Japanese peony. (Horticulture (Sapporo), VII, no. 2, p. 8-10, 1 pl., 1915). In Japanese.
7. KAMEI, S.—On the life-history of *Uredinopsis Pteridis*, with a special bearing on its peridermial stage. (Ann. Phytopath. Soc. Japan, II, p. 207-228, 1 pl., 1930). In Japanese with English résumé.
8. KAMEI, S.—Notes on *Milesina vogesiaca* SYDOW on *Polystichum Braunii* and its peridermial stage on the needles of *Abies Mayriana*, *A. firma* and *A. sachalinensis*. (Transact. Sapporo Nat. Hist. Soc. XI, p. 141-148, 1930).
9. KLEBAHN, H.—Kulturversuche mit heteroecischen Rostpilzen. VII. Bericht (1898). (Zeitschr. f. Pflanzenkr. IX, p. 14-26, 88-99, 137-160, 1899).
10. LAVROV, N.—Contribution toward a mycological flora of the river Yenisei and the islands of the Yenisei Bay. (Ber. Tomsker Staates Univ. LXXXVII, p. 158-177, 1926). In Russian.
11. MATSUMOTO, T.—Impfversuche mit *Melampsora* auf japanischen Weiden. (Transact. Sapporo Nat. Hist. Soc. VI, p. 22-37, 1915).
12. MATSUMOTO, T.—Some experiments with *Melampsora* in Japan. (Ann. Missouri Bot. Gard. VI, p. 309-316, 1919).
13. MATSUMOTO, T.—On the relationship between *Melampsora* on *Salix Pierotii* MIQ. and *Caeoma* on *Chelidonium majus* L. and *Corydalis incisa* PERS. (Bot. Mag. Tokyo, XL, p. 43-47, 1926).
14. MIYABE, K.—On the relationship of *Chrysomyxa expansa* DIET. to *Peridermium Piceae-hondoensis* DIET. (Bot. Mag. Tokyo, XXIX, p. 258-265, 1915).
15. SHIRAI, M.—On the genetic connection between *Peridermium giganteum* (MAYR) TUBEUF and *Cronartium Quercuum* (COOKE) MIYABE. (Bot. Mag. Tokyo, XIII, p. 74-79, 2 pl., 1899).

BOTANICAL LABORATORY,  
TOTTORI AGRICULTURAL COLLEGE,  
TOTTORI, JAPAN



# Weitere Untersuchungen über die pentaploiden *Triticum*-Bastarde. II.<sup>(1)</sup>

Von Hitoshi KIHARA

---

Hierzu zwei Abbildungen im Texte

---

(Eingegangen am 23. Januar 1932)

## Einleitung

Meine weiteren Untersuchungen über die pentaploiden *Triticum*-Bastarde sind seit meiner letzten Publikation (1925) über diesen Gegenstand soweit gediehen, dass eine zweite Mitteilung wohl angemessen sein dürfte. Vor der Darstellung der neuen Ergebnisse möchte ich die Hauptresultate meiner früheren Untersuchungen (1924, 1925) kurz zusammenfassen.

Die pentaploiden *Triticum*-Bastarde haben 35 somatische Chromosomen, also die Summe der haploiden elterlichen Chromosomen (14+21). In der I. Reifungsteilung treten 14 Gemini und 7 Univalente auf (7 AA+7 BB+7 D). Die ersteren verhalten sich ganz normal, die letzteren werden in der I. Anaphase alle oder fast alle längsgeteilt (KIHARA 1931). Die so entstandenen Spalthälften der Univalenten werden in der II. Reifungsteilung ohne weitere Längsteilung zufallsmässig auf die beiden Pole verteilt. Ihre Verteilungsweise findet danach, wenn man von einer Elimination absieht, ihren Ausdruck in der binomialen Formel  $(0,5+0,5)^7$ . In Wirklichkeit findet aber eine nicht zu vernachlässigende Univalentenelimination statt, wodurch die Verteilung mehr oder weniger schief wird (vgl. 1924, S. 70-74).

In den Gonen der 35-chromosomigen F<sub>1</sub>-Pflanzen sind die Chromosomenzahlen von 14 bis 21 möglich. Dementsprechend sind auch in der F<sub>2</sub>-Generation 28 bis 42 somatische Chromosomen zu erwarten. Bei freier Kombination der verschiedenchromosomigen Keimzellen und ohne Univalentenelimination müssten sich, wenn alle diese Chromosomengarnituren gleiche Lebensfähigkeit bewirken würden, die verschiedenchromosomigen F<sub>2</sub>-Zygoten mit folgender Häufigkeit einstellen.

---

(1) Contributions from the Laboratory of Genetics, Kyoto Imperial University.  
No. 22.

TABELLE 1

Theoretische Häufigkeit der verschiedenchromosomigen (28-42) Zygoten in der  $F_2$ -Generation der pentaploiden *Triticum*-Bastarde

Chromosomenzahl	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Zahl d. Indiv. (Su. 16384)	1	14	91	364	1001	2002	3003	3432	3003	2002	1001	364	91	14	1

Wie sich im einzelnen die möglichen Chromosomenformeln dieser 28- bis 42-chromosomigen  $F_2$ -Individuen darstellen, zeigt Tab. 2.

TABELLE 2

Chromosomenformeln der in der  $F_2$ -Generation der pentaploiden *Triticum*-Bastarde möglichen verschiedenchromosomigen Individuen

Chromosomenz. in F <sub>1</sub> F <sub>2</sub>		Chromosomenf. d. "fertilen" Komb. I	Chromosomenf. d. "sterilen" Komb.		
			II	III	IV
35 →	28	14 <sub>II</sub>			
	29	14 <sub>II</sub> +1 <sub>I</sub>			
	30	14 <sub>II</sub> +2 <sub>I</sub>	15 <sub>II</sub>		
	31	14 <sub>II</sub> +3 <sub>I</sub>	15 <sub>II</sub> +1 <sub>I</sub>		
	32	14 <sub>II</sub> +4 <sub>I</sub>	15 <sub>II</sub> +2 <sub>I</sub>	16 <sub>II</sub>	
	33	14 <sub>II</sub> +5 <sub>I</sub>	15 <sub>II</sub> +3 <sub>I</sub>	16 <sub>II</sub> +1 <sub>I</sub>	
	34	14 <sub>II</sub> +6 <sub>I</sub>	15 <sub>II</sub> +4 <sub>I</sub>	16 <sub>II</sub> +2 <sub>I</sub>	
	35	14 <sub>II</sub> +7 <sub>I</sub>	15 <sub>II</sub> +5 <sub>I</sub>	16 <sub>II</sub> +3 <sub>I</sub>	17 <sub>II</sub>
	36	15 <sub>II</sub> +6 <sub>I</sub>	16 <sub>II</sub> +4 <sub>I</sub>	17 <sub>II</sub> +2 <sub>I</sub>	17 <sub>II</sub> +1 <sub>I</sub>
	37	16 <sub>II</sub> +5 <sub>I</sub>	17 <sub>II</sub> +3 <sub>I</sub>	18 <sub>II</sub> +1 <sub>I</sub>	18 <sub>II</sub>
	38	17 <sub>II</sub> +4 <sub>I</sub>	18 <sub>II</sub> +2 <sub>I</sub>	19 <sub>II</sub>	
	39	18 <sub>II</sub> +3 <sub>I</sub>	19 <sub>II</sub> +1 <sub>I</sub>		
	40	19 <sub>II</sub> +2 <sub>I</sub>	20 <sub>II</sub>		
	41	20 <sub>II</sub> +1 <sub>I</sub>			
	42	21 <sub>II</sub>			

Die  $F_2$ -Nachkommen sind, je nach ihrer Chromosomenzusammensetzung, hochgradig steril bis vollfertil. Die von mir als "fertil" bezeichneten Chromosomenkombinationen sind mit einer teilweisen bis vollen Fertilität der betreffenden Individuen verbunden. Sie sind so beschaffen, dass sie (insofern sie nicht schon in  $F_2$  die beiden Grenztypen, 14<sub>II</sub> und 21<sub>II</sub>, realisieren) früher oder später, im Laufe der Generationen, in der Verminderungsgruppe (d.h. bei weniger als 35 Chromosomen) zur Chromosomenzahl und zum Genomtyp AABB des Emmerelaters (auffallend rasch) und in der Vermehrungsgruppe (d.h. bei mehr als 35 Chromosomen) zur Chromosomenzahl und zum Genomtyp



AABBDD des Dinkel-Elters (viel langsamer) zurückkehren. Hiermit wird auch völlige Fertilität und Konstanz in bezug auf die Chromosomenzahl restituiert. Die Pflanzen mit "sterilen" Chromosomenkombinationen hingegen sind teilweise bis gänzlich steril. Ihre Chromosomensortimente sind so zusammengesetzt, dass sie nie die elterlichen Chromosomenzahlen abspalten können. Ferner sind sie auch in den Fällen, in welchen Univalente fehlen, also konstante Chromosomenzahlen vorliegen, entweder lebensunfähig oder in ihrer Vitalität stark geschwächt<sup>(1)</sup>.

Anfangs waren als wichtigste die Fragen zu lösen, 1. ob alle Chromosomenzahlen von 28 bis 42 realisierbar sind und 2., wenn dies der Fall wäre, ob sie alle mit den erwarteten Frequenzen realisiert werden. Wenn beides zuträfe, müsste sich eine der in Tab. 1 gebrachten nahe kommende Verteilung der verschiedenchromosomigen F<sub>2</sub>-Pflanzen ergeben. Bei Berücksichtigung der tatsächlich stattfindenden Univalentenelimination würde nur eine Schiefheit herbeigeführt werden. Während die erste Frage bejahend beantwortet werden konnte<sup>(2)</sup>, hat sich in bezug auf die zweite ein sehr auffälliger Unterschied zwischen Erwartung und Befund herausgestellt, wie ohne weiteres aus Tab. 3 hervorgeht.

TABELLE 3

Häufigkeit der 28- bis 42-chromosomigen Pflanzen in der F<sub>2</sub>-Nachkommenschaft der pentaploiden Bastarde

Chromosomenz. (erwartet)	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
	1	14	91	364	1001	2002	3003	3432	3003	2002	1001	364	91	14	1
4 verschiedene Kreuz. <sup>(3)</sup> (KIHARA)	—	—	1	1	1	1	—	1	1	2	8	2	1	—	1 <sup>(4)</sup>
<i>vulg.</i> × <i>dicoccum</i> (THOMPSON u. H.)	6	7	5	4	2	—	1	—	2	1	—	—	—	—	—
<i>vulg.</i> × <i>polon.</i> (SAX)	5	—	—	—	1	—	1	5	2	—	—	—	—	—	1

(1) Bis jetzt habe ich nur 40-chromosomige konstante Zwerge (also mit 20n) gefunden, die sogar im Laufe der Generationen unerwarteterweise z.T. ziemlich fertil geworden sind, worauf ich a. a. O. zurückkommen werde.

(2) Dass bis jetzt in F<sub>2</sub> keine 41-chromosomigen Pflanzen gefunden wurden, ist sicher nur ein Zufall.

(3) *T. turgidum* × *T. compactum*, *T. polonicum* × *T. spelta*, *T. durum* × *T. vulgare*, *T. polonicum* × *T. compactum*.

(4) Es ist eine bis jetzt noch nicht aufgeklärte Eigentümlichkeit der Verbindungen *T. polonicum* × *T. spelta* u. *T. turgidum* × *T. compactum*, dass sie in F<sub>2</sub> verhältnismässig viele Pflanzen der Vermehrungsgruppe geben, während die Kreuzung *T. durum* × *T. vulgare* sich in dieser Hinsicht umgekehrt verhält. Daher die vielen Vertreter dieser Gruppe in meinen Versuchen.

Der Ausfall der mittleren Chromosomenzahlen ist ausserordentlich gross. Wie die näheren karyologischen Untersuchungen gezeigt haben (KIHARA 1924, S. 45), sind "sterile" Kombinationen nur ausnahmsweise zu finden. Diese Tatsache, in Verbindung mit der Beobachtung, dass viele von den an den pentaploiden Pflanzen geernteten Körnern nicht keimen bzw. schwache, bald absterbende Keimlinge geben, hat mich veranlasst, den Hauptgrund der Sterilität dieser Bastarde<sup>(1)</sup> in der Zygotenelimination zu suchen. Als zweite mögliche Ursache habe ich eine teilweise Funktionsunfähigkeit der Pollenkörner mit intermediären Chromosomenzahlen in Betracht gezogen, vor allem auf Grund der Konkurrenzversuche mit 20- und 21-chromosomigem Pollen (KIHARA 1924, S. 184-185).

Auf diese recht komplizierten Fragen konzentrierten sich meine weiteren Untersuchungen über die pentaploiden Weizenbastarde. Im J. 1925, vor meiner Auslandsreise, habe ich kurz über einen kleinen Zertationsversuch berichtet, der auf eine selektive Elimination der Pollenkörner mit intermediären Chromosomenzahlen hinwies. Kurz nachher (1925) erschien eine Arbeit von WATKINS, der auf Grund beweisender Versuche zeigte, dass das Unbefruchtetbleiben funktionsfähiger Embryosäcke die Hauptursache der Sterilität der pentaploiden Bastarde ist. Nach meiner Rückkehr aus Europa habe ich in grösserem Massstab Versuche z. T. in Sapporo, z. T. in Kyoto angestellt, um näher in dieses Problem einzudringen. Ein Teil dieser Versuche ist im folgenden beschrieben.

## Embryobildung und Körneransatz

### I. Versuch. $F_1$ -Bastard $T. polonicum \times T. spelta$

Bei der Analyse der Sterilität der pentaploiden Bastarde war es zunächst von grosser Wichtigkeit, zahlenmässig festzustellen, welchen Anteil bei ihrem Zustandekommen die Zygotenelimination und welchen die verminderte Funktionsfähigkeit bzw. Untauglichkeit der Pollenkörner<sup>(2)</sup> hat. Zu diesem Zweck habe ich in einem Versuch mit dem Bastard  $T. polonicum \times T. spelta$  das Verhältnis zwischen der Anzahl

(1) In Sapporo war die Verbindung  $T. polonicum \times T. spelta$ , welche das Hauptmaterial für meine karyologischen Untersuchungen in  $F_2$  geliefert hat, hochgradig steril.

(2) Dass die Eizellen alle oder fast alle an sich funktionsfähig sind, stand bereits fest (vgl. auch S. 41).

der gebildeten Embryonen und unbefruchtet gebliebenen Embryosäcke und derjenigen der vollentwickelten Körner möglichst genau bestimmt. Die Versuchsanordnung war wie folgt.



Abb. 1. Schematische Aufrisse von 2 Ährenpaaren (AA' und BB') aus Versuch I. Links Vergleichsähren (A und B), rechts die zur Fixierung gebrauchten Ähren (A' und B'). Blütchen der Vergleichsähren, die Körner gegeben haben, sind schwarz, diejenigen der mikroskopisch untersuchten Ähren, in welchen Embryoanlagen gefunden wurden, rot, die mit degenerierten Embryosäcken punktiert. Das mit x bezeichnete Blütchen (Ähre B') ist verloren gegangen.

Bei 6 isolierten Aehren des Bastards ist auf Grund regelmässiger Beobachtung der Zeitpunkt des Aufblühens für die zwei untersten Blüten in jedem Aehrchen notiert worden. Die Fruchtknoten aller dieser Blüten sind 48 (—72) Stunden nach dem Aufblühen getrennt fixiert und in Paraffinschnitten<sup>(1)</sup> untersucht worden. Für jede der auf diese Art behandelten 6 Aehren ist gleichzeitig immer an derselben Pflanze eine gleich kräftige und ebensoweit entwickelte Vergleichsähre gesäckt worden. Die 6 Vergleichsähren hat man ohne irgend welche Eingriffe reif werden lassen<sup>(2)</sup>; nach der Reife ist der Körneransatz der zwei untersten Blüten in jedem Aehrchen untersucht worden. Um nach Möglichkeit genau vorzugehen, habe ich mich bei der Untersuchung der 6 Aehrenpaare schematischer Aufrisse bedient (Abb. 1). Jedes Aehrchen und seine zwei untersten Blüten waren mit Buchstaben oder Zahlen bezeichnet; die Befunde waren für jedes Blüten getrennt eingetragen. Eine Zusammenfassung der Resultate dieses Versuchs bringt Tab. 4.

TABELLE 4

I. Versuch,  $F_1$ -Bastard *T. spelta* × *T. polonicum*. Vergleich zwischen der Anzahl der gebildeten Embryonen und der vollentwickelten Körner bei Selbstbestäubung (Sapporo 1929)

Sechs zur mikroskopischen Untersuchung gebrauchte Aehren				Sechs Vergleichsähren			
Anzahl d. Embryosäcke				Körneransatz			Prozent-satz d. elimin. Zygoten
mit Embryo	ohne Embryo		Summe	vollentwick. Körner	keine Körner	Summe	
	gesund	degeneriert					
93	129	4	226	42	210	262	24,39 ± 4,02%
41,15 ± 3,27%	57,08%	1,77%	100	16,66 ± 2,35%	83,34%	100	

Auf 226 Blüten sind also 129 mit gesunden, aber keine Embryobildung aufweisenden Embryosäcken gefunden worden; nur in 4 Fällen (ca. 1,8%) wies der Embryosack Degenerationszeichen auf (Abb. 2d). Der Rest, 93 Blüten, enthielt Embryonanlagen. Man sieht also, dass 1. von

(1) Gefärbt mit Hämatoxylin nach HEIDENHAIN.

(2) Bei der Selbstbestäubung der 12 Aehren ist keine Nachhilfe geleistet worden.



allen Embryosäcken *ca.* 57,1%, die im mikroskopischen Bild gesund aussehen (vgl. Abb. 2a), unbefruchtet bleiben, 2. in fast allen übrigen Embryosäcken (*ca.* 41,1%) zwar ein Embryo angelegt wird, aber im Verlauf der weiteren Entwicklung mehr als die Hälfte der Embryonen abortieren, wie die Zahl der vollentwickelten Körner in den Vergleichsähren zeigt (vgl. zweite Abteilung der Tab. 5). Auf *ca.* 41,1% Embryosäcke mit Embryobildung, die in den mikroskopisch untersuchten Ähren festgestellt wurden, entfallen nur *ca.* 16,7% reife Körner in den Vergleichsähren. Aus der Differenz dieser beiden Zahlen ergibt sich annähernd der Grad der Zygotenelimination, der *ca.* 24,4% beträgt<sup>(1)</sup>. Abb. 2b–e bringen neben einem Embryosack mit gesunden Embryo und Endosperm (b) zwei Embryosäcke (c und e), deren weitere Entwicklung schon sehr früh unterbrochen ist. In Abb. c ist ein interessanter Fall mit einem Embryo, aber ohne Endosperm (die grossen Zellen rechts am Rande sind Antipodenzellen) dargestellt, in Abb. e sieht man einen in Auflösung begriffenen Embryo und ein degeneriertes Endosperm. (Die Embryosäcke in Abb. a, b und c gehören zur Pflanze mit 14<sub>II</sub>+6<sub>I</sub> aus Versuch II.)

Die Sterilität des untersuchten Bastards wird danach zum grössten Teil durch das Ausbleiben der Befruchtung verursacht.

Dass die unbefruchtet gebliebenen Eizellen funktionsfähig sind, hat eine umfangreiche, mit grosser Sorgfalt im J. 1931 ausgeführte Aequationskreuzung (*T. spelta* × *T. turgidum*) × *T. spelta* einwandfrei gezeigt. Von 270 kastrierten und künstlich bestäubten Blüten gelang es einem meiner Mitarbeiter, Herrn SH. WAKAKUWA, 244 (also 90,37%) reife Körner zu erhalten<sup>(2)</sup>. Wenn man die technischen Schwierigkeiten der Kreuzungsversuche berücksichtigt, muss man zugeben, dass die im Präparat gesund aussehenden Embryosäcke tatsächlich funktionsfähig sein müssen und dass eine selektive Elimination von ♀ Gameten im Versuch von WAKAKUWA so gut wie keine Rolle spielt. Unter diesen Umständen lag es am nächsten, das Unbefruchtetbleiben des überwiegenden Teils gesunder Embryosäcke (Tab. 4) des untersuchten Bastards auf die Beschaffenheit des Pollens zu schieben, und zwar nach den in F<sub>2</sub> erhaltenen Resultaten auf die verminderte bis gänzlich aufgehobene Funktionsfähigkeit und Elimination der Pollen-

(1) Degenerierte Embryonen habe ich nur in zwei Embryosäcken gesehen (Abb. 2e). Dass dieser Prozess allmählich vor sich geht und die Anzahl solcher Embryonen im Laufe der Entwicklung steigt, geht aus Versuch II (S. 45) hervor, bei dem die Fruchtknoten durchschnittlich um etwa 48 Stunden später fixiert wurden.

(2) Die Resultate dieses Versuchs sollen in einer dritten (gemeinsamen) Mitteilung der vorliegenden Serie aufgenommen werden.



Abb. 2 a-e. Embryosäcke aus Blütchen, die in verschiedenen Zeiträumen nach dem Aufblühen fixiert waren. Vergr. ca. 96. a-c. Aus dem Individuum mit  $14\Pi+6I$ . d-e. Aus der pentaploiden Verbindung *T. polonicum*  $\times$  *T. spelta* mit  $14\Pi+7I$ .

- a. Ganz gesunder, aber unbefruchtet gebliebener Embryosack. Die Antipoden sind ausserordentlich stark entwickelt. Fixiert 144 Stunden nach dem Aufblühen.
- b. Embryosack mit einem gesunden Embryo und ebensolchem Endosperm. Fixiert 96 Stunden nach dem Aufblühen.
- c. Embryosack mit einem Embryo, aber ohne Endosperm. Fixiert 120 Stunden nach dem Aufblühen.
- d. Degenerierter Embryosack. Fixiert 73 Stunden nach dem Aufblühen.
- e. Embryosack mit einem abortiven Embryo. Endosperm degeneriert. Fixiert 73 Stunden nach dem Aufblühen.

körner mit intermediären Chromosomenzahlen. Darauf, dass hier noch ein Faktor mitwirken kann, der mit der hohen Sterilität der Verbindung *T. polonicum*  $\times$  *T. spelta* in Sapporo zusammenhängt, soll in der Diskussion hingewiesen werden.

Näheres Licht in der Frage der Elimination von Pollenkörnern konnten nur Zertationsversuche bringen, die sowohl von mir als auch von anderen Forschern (KIHARA 1925 und unveröff., WATKINS 1927, NISHIYAMA 1928, THOMPSON und CAMERON 1928, SAX 1928) vorliegen (vgl. Diskussion, S. 55). Ihre Resultate können nur so gedeutet werden, dass tatsächlich eine selektive Elimination (durch Keimungsunfähigkeit bzw. Konkurrenz) der Pollenkörner mit intermediären Chromosomenzahlen zugunsten der selten vertretenen Grenzwerte 14 und 21 und der diesen nahestehenden Zahlen stattfindet. Durch einen Zertationsversuch mit 20- und 21-chromosomigem Pollen (die Mutter war ein 40-chromosomiger konstanter Zwerg) konnte NISHIYAMA zahlenmässig das Konkurrenzverhältnis zwischen diesen zwei Pollensorten ausdrücken. Er zeigte, dass die Befruchtung durch 20- und 21-chromosomigen Pollen ungefähr im Verhältnis 1:8 stattfindet<sup>(1)</sup>.

Das Wachstum der Pollenschläuche geht also bei dem 20-chromosomigen Pollen bedeutend langsamer vor sich als bei dem 21-chromosomigen. Man kann sich leicht vorstellen, dass die Pollenschläuche um so langsamer wachsen, je näher die Chromosomenzahlen an den Mittelwert heranrücken, und dass schliesslich die Pollenkörner mit Chromosomenzahlen, die diesem entsprechen oder dicht um ihn herumliegen, also die am zahlreichsten vertretenen, z. T. ein so langsames Schlauchwachstum haben, dass sie praktisch funktionsunfähig sind, z.T. auch gar nicht mehr keimen können. Wenn diese Annahme richtig ist, müsste man erwarten, dass bei sehr reichlicher Bestäubung oder unter sehr günstigen Bedingungen für das Pollenschlauchwachstum bzw. bei dem Zusammenwirken dieser beiden Faktoren eine genügende Anzahl funktionierender Pollenkörner<sup>(2)</sup> auf die Narbe fällt, damit der einzige Embryosack in jedem Blütchen befruchtet wird. Besonders günstige Bedingungen für das Pollenschlauchwachstum sind in Kyoto

(1) Lägen die beiderlei Pollenkörner in gleicher Anzahl vor (wenn keine Univalentenelimination stattfände), dann würde dieses Verhältnis ungefähr 1:20 (bzw. bei mässiger Univalentenelimination 1:12) sein.

(2) Man muss im Auge behalten, dass sehr oft, trotzdem nur ein Embryosack in einer Blüte zur Befruchtung vorliegt, eine grössere Anzahl tüchtiger Pollenkörner auf die Narbe fallen muss, damit die Befruchtung ausgeführt wird.

gegeben, wo die Blühzeit der meisten Weizen in die Regenperiode fällt und die Narben dank der grossen Luftfeuchtigkeit lange in gutem Zustand bleiben, so dass auch langsamer wachsende Schläuche ihre Aufgabe erfüllen können. Hier habe ich mit meinen Mitarbeitern im J. 1931 eine Zertationskreuzung, *T. turgidum*  $\times$  (*T. spelta*  $\times$  *T. turgidum*), ausgeführt und aus 100 sorgfältig kastrierten und sehr reichlich bestäubten Blüten 92 Körner gewonnen. Gute Bedingungen für das Pollenschlauchwachstum sind wahrscheinlich der wichtigere Faktor. Die pentaploide Verbindung *T. spelta*  $\times$  *T. polonicum* hat in Kyoto ohne jede Nachhilfe bei der Selbstbestäubung einen sehr hohen Fertilitätsgrad gezeigt, worauf ich weiter unten zurückkommen werde. Es wäre von grösstem Interesse die Chromosomenverhältnisse in der Nachkommenschaft der in Kyoto gezogenen  $F_1$ -Pflanzen zu untersuchen und die Anzahl der "sterilen" Chromosomenkombinationen festzustellen. Der Habitus dieser Nachkommenschaft (zahlreiche schwache und zwergige Pflanzen) weist jedenfalls darauf hin, dass die "sterilen" Kombinationen hier häufig vertreten sind, was dafür spricht, dass ein Teil der in Sapporo funktionsunfähigen und eliminierten Pollenkörner in Kyoto funktionieren kann. Eine eingehende karyologische Untersuchung dieser  $F_2$  wird in meinem Laboratorium in nächster Zukunft unternommen werden.

## II. Versuch. 34-chromosomiges Individuum ( $14_{II} + 6_I$ ), das aus der Kreuzung eines 40-chromosomigen Zwerges (D-2g) mit *T. polonicum* gewonnen wurde.

Dieser Versuch ist im Sommer des J. 1926 in Kyoto, auf ähnliche Weise wie Versuch I, ausgeführt worden. Die Fixierung ist 96 (-120) Stunden nach dem Aufblühen unternommen worden.

Die 34-chromosomige Versuchspflanze mit der Chromosomenformel  $14_{II} + 6_I$  stellte erwartungsgemäss (neben der 36-chromosomigen) den sterilsten Typ unter den "fertilen" Chromosomenkombinationen dar (vgl. KIHARA 1924); ihr bedeutend niedrigerer Fertilitätsgrad als der des pentaploiden Bastards *T. spelta*  $\times$  *T. polonicum* unter gleichen Bedingungen (in Kyoto) steht damit in gutem Einklang.

Als Versuchsmaterial dienten 20 Aehrenpaare. Die Resultate fasst Tab. 5 zusammen.



TABELLE 5

II. Versuch. 34-chromosomiges Individuum mit der Chromosomeformel  $14_{II}+6_I$ . Vergleich zwischen der Anzahl der gebildeten Embryonen und der vollentwickelten Körner bei Selbstbestäubung (Kyoto 1926)

Zwanzig zur mikroskopischen Untersuchung gebrauchte Ähren.

Zwanzig Vergleichsähren

Anzahl d. Embryosäcke				Körneransatz			Prozen- satz d. elim. Zyg.
mit Em- bryo	Embryo		Summe	vollentwick. Körner	keine Körner	Summe	
	gesund	degeneriert					
337	643	2	982 <sup>(1)</sup>	291	691	982 <sup>(1)</sup>	
34,32%	65,48%	0,20%	100	29,63%	70,37%	100	4,69%

Aus der Tabelle geht hervor, dass wir in diesem Falle das Ausbleiben der Befruchtung als die fast ausschliessliche Ursache der Sterilität ansehen müssen. Die Zahl der eliminierten Zygoten (4,69%) ist so klein, dass sie praktisch kaum ins Gewicht fällt. Zygotenelimination findet aber sicher statt, wie die näheren mikroskopischen Untersuchungen gezeigt haben. In Tab. 6 finden sich verschiedene Degenerationerscheinungen, die in 17 Embryosäcken gefunden wurden, zusammengestellt.

TABELLE 6

Embryonen sicher degeneriert	2
„ wahrscheinlich degeneriert	9
Endosperm schlecht entwickelt	1
Embryo u. Endosperm degeneriert (?)	1
Endosperm fehlt, Embryo vorhanden	3 (Abb. 2c)
Endosperm entwickelt, kein Embryo (?)	1
Summe	17

Zur Erklärung der Sterilitätsverhältnisse bei unserer Versuchspflanze seien folgende Ueberlegungen angestellt.

(1) Dass die Summe der untersuchten Blüthen in den zur Fixierung und zum Vergleich gebrauchten Ähren so genau übereinstimmt, ist natürlich nur ein Zufall.

Wie bei allen Bastarden vom *Triticum*-Typ kann die Häufigkeit der verschiedenchromosomigen Gonen nach der Formel  $(a+b)^n$  berechnet werden ( $n$  = Univalentenzahl). Ohne Univalentenelimination wäre  $a = b = 0,5$ . Diese findet aber sicher statt. Nach NISHIYAMA's (1928) Befunden bei einer Aequationskreuzung (41-chromosomiges Individuum  $\times$  40-chromosomiger Zwerg) ist für  $a$  ca. 0,7 und dementsprechend für  $b$  ca. 0,3 zu setzen. Meine direkten mikroskopischen Beobachtungen an PMZ von 41-chromosomigen Pflanzen (1924) ergaben für  $a$  und  $b$  0,6 bzw. 0,4. Wir wollen nun für den vorliegenden Fall mit 6 Univalenten die Häufigkeit der 14- bis 20-chromosomigen Gonen bei mässiger (auf Grund der Formel  $(0,6+0,4)^6$ ) und bei stärkerer (auf Grund der Formel  $(0,7+0,3)^6$ ) Elimination der Univalenten berechnen<sup>(1)</sup>. Die sich für beide Fälle ergebenden Zahlenreihen sind aus Tab. 7 zu ersehen.

TABELLE 7

Verhältniszahlen der verschiedenchromosomigen (14-20) Gonen berechnet für das 34-chromosomige (14<sub>II</sub>+6<sub>r</sub>) Individuum bei 1. mässiger und 2. stärkerer Univalentenelimination

Chromosomenzahl	14	15	16	17	18	19	20
1. bei mäss. Elimin. (0,6+0,4) <sup>6</sup>	0,047	0,187	0,311	0,276	0,138	0,037	0,004
2. bei stärkerer Elimin. (0,7+0,3) <sup>6</sup>	0,118	0,303	0,324	0,185	0,059	0,010	0,001

Dass 14-chromosomige Pollenkörner vollkommen tüchtig sind, steht ausser Zweifel. Sie sind aber selten vertreten; die relativ funktionsfähigen mit dem hohen Grenzwert sind noch viel seltener (die sicher tüchtigen 21-chromosomigen fehlen gänzlich), während die Hauptmasse des Pollens aus Körnern mit intermediären Zahlen besteht, die nicht aktiv genug sein dürften, so dass die Befruchtung in den meisten Fällen unterbleibt, besonders wenn nicht für eine sehr reichliche Bestäubung gesorgt wird. Wenn wir die Sachlage so auffassen, dann wird es leicht verständlich, warum die Rückkehr zum 28-chromosomigen Eltertyp in der Verminderungsgruppe immer so plötzlich vor sich geht (vgl. KIHARA 1924). Noch ein Moment

(1) Bei der Annahme, dass die Verlustwahrscheinlichkeit für jedes Univalente ungefähr gleich gross ist. Dass diese Annahme für 2 Univalente,  $f$  und  $g$ , zulässig ist, hat NISHIYAMA (1928) bewiesen.

dürfte nach dieser Richtung hin mitwirken, das vielleicht besonders bei der Selbstbestäubung der unfruchtbarsten unter den "fertilen" Chromosomenkombinationen zu berücksichtigen wäre, nämlich eine Elimination der Eizellen durch Versagen bei der Befruchtung. Verschiedene Forscher haben in manchen Aequationskreuzungen mit Emmer als Pollenlieferanten (vgl. Diskussion S. 56-8) einen Ueberschuss an 28-chromosomigen Pflanzen beobachtet. Dieser war so gross, dass nach ihnen (vgl. auch WATKINS 1930) der erwartete Prozentsatz 14-chromosomiger Eizellen weit dahinter zurückblieb. Meiner Ansicht nach liegen aber 14-chromosomige Eizellen in genügender Anzahl vor, wenn man nur eine stärkere Elimination (nach  $(0,7+0,3)^n$ ) der Univalenten annimmt, wie sie ja tatsächlich nach NISHIYAMA (1928) vorkommt. Es bleibt dann allerdings die Frage übrig, warum eben alle diese Eizellen befruchtet werden. Man kann vielleicht daran denken, dass ihre normale Chromosomengarnitur sich bei dem Eindringen der 14-chromosomigen Pollenschläuche des Rückkreuzungselters in den Embryosack oder bei dem Ablauf des Befruchtungsvorgangs dahin auswirkt, dass diese Prozesse erleichtert werden bzw. im normalen Tempo vor sich gehen, während die Eizellen mit intermediären Chromosomenzahlen mehr oder weniger versagen. Nebenbei möchte ich erwähnen, dass eine Konkurrenz der weiblichen Gonen, wie sie von RENNER (1921) für *Oenothera* angegeben wird, bei den pentaploiden Weizenbastarden sicher nicht stattfindet<sup>(1)</sup>.

Ausserdem bleibt noch zu berücksichtigen, dass der Unterschied in bezug auf den Grad der Zygotenelimination zwischen Versuch I und II sehr bedeutend ist. Die Zygotenelimination ist im letzteren Fall sehr gering (ca. 4,7%), trotzdem sie hier in noch grösserem Masse zu erwarten war (die theoretische Mode der somatischen Chromosomenzahlen in der Nachkommenschaft liegt hier bei 34; vgl. KIHARA 1924) als bei den Bastarden mit  $14_{II}+7_I$ . Eine befriedigende Erklärung dieser Tatsache brachte die karyologische Untersuchung der Nachkommenschaft des Individuums mit  $14_{II}+6_I$ , die mein Schüler Herr M. MORIYA ausgeführt hat (unveröffentlicht). In Tab. 8 findet man die Uebersicht der Resultate.

Aus Tab. 8 entnimmt man, dass auf 87 untersuchte Individuen 27, also ca. 31%, „sterile“ Chromosomenkombinationen entfallen<sup>(2)</sup>.

(1) In den vielen von mir untersuchten Fällen, war es immer die unterste Makrospore, die den Embryosack abgegeben hat.

(2) Es ist bemerkenswert, dass die Pflanze mit 15 Bivalenten ein Zwerg und vollkommen steril war.

TABELLE<sup>18</sup>

Chromosomenkombinationen in der Nachkommenschaft der Pflanze mit  
 $14_{II}+6_I$

Chromosomenzahl	Chromosomenformel	Zahl d. Individuen	%
28	$14_{II}+0_I$	6 . . . . . 6	6.9
29	$14_{II}+1_I$	13 . . . . . 13	14.9
30	$14_{II}+2_I$	23 } . . . . . 24	27.6
30	$15_{II}+0_I^*$	1 }	
31	$14_{II}+3_I$	9 } . . . . . 13	14.9
31	$15_{II}+1_I^*$	4 }	
32	$14_{II}+4_I$	5 }	
32	$15_{II}+2_I^*$	3 }	9.2
32	$16_{II}+0_I$	0 }	
33	$14_{II}+5_I$	2 }	
33	$15_{II}+3_I^*$	5 }	8.0
33	$16_{II}+1_I$	0 }	
34	$14_{II}+6_I$	2 }	
34	$15_{II}+4_I^*$	1 }	5.7
34	$16_{II}+2_I^*$	2 }	
34	$17_{II}+0_I$	0 }	
35	$15_{II}+5_I^*$	2 }	
35	$16_{II}+3_I^*$	4 }	6.9
35	$17_{II}+1_I$	0 }	
36	$16_{II}+4_I^*$	2 }	
36	$17_{II}+2_I$	0 }	2.3
36	$18_{II}+0_I$	0 }	
37	$17_{II}+3_I^*$	2 }	
37	$18_{II}+1_I$	0 }	3.4
38	$18_{II}+2_I$	0 }	
38	$19_{II}+0_I$	0 }	0.0
39	$19_{II}+1_I$	0 . . . . . 0	0.0
40	$20_{II}+0_I$	0 . . . . . 0	0.0
Summe		87	

„Fertile“ Chromosomenkombinationen: 60 68,98%

„Sterile“ Chromosomenkombinationen: 27 31,02%

\* Die realisierten „sterilen“ Kombinationen sind mit Sternchen bezeichnet.



Es haben sich also unter den guten Bedingungen in Kyoto nicht nur die betreffenden Embryosäcke nach erfolgreicher Befruchtung zu Körnern entwickelt, sondern diese selbst waren auch keimungsfähig und die Keimlinge blieben am Leben. Wären sie in embryonalen Stadien abgestorben (oder hätten sie z. T. keimungsunfähige Körner bzw. nach der Keimung eingehende Pflanzen gegeben), dann hätten wir die auf Grund der Erfahrungen in Sapporo für diese Verbindung erwartete Zygotenelimination erhalten. Nur dass der Prozentsatz der eliminierten Zygoten hier noch höher gewesen wäre als bei Pflanzen mit  $14_{II} + 7_I$ . Meine Annahme, dass für diesen Unterschied zwischen Versuch I und Versuch II die klimatischen Verhältnisse von Sapporo und Kyoto verantwortlich zu machen waren, hat ein im nächsten Abschnitt behandelter Vergleich der Fruchtbarkeit pentaploider Bastarde, die an diesen beiden Orten gezogen waren, in vollem Masse bestätigt.

### Körneransatz und äussere Bedingungen

Die im J. 1918 in Sapporo angefangenen Versuche mit pentaploiden Weizenbastarden habe ich in Kyoto, wohin ich im J. 1920 umgezogen bin, fortgesetzt.

In Kyoto fiel mir bald die hohe Fertilität der pentaploiden Verbindung *T. polonicum*  $\times$  *T. spelta* auf. Die  $F_1$ -Pflanzen gaben jahraus, jahrein einen fast vollständigen Körneransatz, während sie in Sapporo im Durchschnitt etwa 7,5 Körner pro Aehre lieferten (KIHARA 1924). Diese Beobachtung veranlasste mich dazu, einen genaueren Vergleich zwischen dem in Sapporo und dem in Kyoto von diesen Bastarden gezeigten Fertilitätsgrad vorzunehmen.

TABELLE 9

Fruchtbarkeit des pentaploiden  $F_1$ -Bastards *T. polonicum*  $\times$  *T. spelta* und reziprok in Sapporo und in Kyoto.

Kreuzungs- richtung	Versuchs- ort u. Jahrg.	Zahl d.		Körneransatz im				Durchschnittl. Z. d. Kö. pro	
		Aehren	Aehrchen	1.	2.	3.	4. Bl.	Aehre	Aehrch. (1-2. Bl.)
<i>T. pol.</i> $\times$ <i>sp.</i>	Sapporo (1919)	2	36	15 <sup>(1)</sup>				7,5	—
<i>T. sp.</i> $\times$ <i>pol.</i>	Sapporo (1926)	10	206	40	23	—	—	6,8	0,3301
<i>T. pol.</i> $\times$ <i>sp.</i>	Kyoto (1928)	10	228	163	117	—	—	28,0	1,2281

(1) In allen 4 Blütchen zusammen.

TABELLE 10

Fruchtbarkeit des pentaploiden Bastards *T. vulgare* × *T. durum* und reziprok in Sapporo (1926).

Kreuzungs- richtung	Zahl d. Aehren	Körneransatz im		Durchschnittl. Z. d. Kö. pro	
		1.	2. Blütenchen	Aehre	Aehrchen (1-2. Bl.)
<i>T. vulg.</i> × <i>dur.</i>	19	304	244	28,84	1,691
<i>T. dur.</i> × <i>vulg.</i>	10	150	125	27,5	1,694

Tabellen 9 und 10 zeigen erstens, dass die Fertilität der Verbindung *T. polonicum* × *T. spelta* viel höher in Kyoto ist als in Sapporo und zweitens, dass zwei verschiedene pentaploide Verbindungen sich in dieser Beziehung an demselben Orte sehr verschieden verhalten können. Auch kann man aus den beiden Tabellen ersehen, dass die Reziprozität der Kreuzung und wahrscheinlich auch der Jahrgangsfaktor keine grosse Rolle dabei spielen. Die Bestimmungen des Sterilitätsgrades einer bestimmten Verbindung sind also nur dann vergleichbar, wenn die in Frage stehenden Pflanzen an demselben Orte aufgewachsen sind.

Diese Schlüsse werden bestätigt und ergänzt durch die Tab. 11, in der die Fertilitätsgrade einer Reihe verschiedener pentaploider Bastarde (und ihrer Eltern) zusammengestellt sind, die in Kyoto im J. 1931 angebaut waren.

Aus Tab. 11 geht hervor, dass die Fertilität verschiedener pentaploider Verbindungen an einem und demselben Orte sehr verschieden sein kann. *T. rubiginosum* z. B. erniedrigt bedeutend den Fertilitätsgrad einer Verbindung, während *T. turgidum* ihn erhöht. Wenn die beiden in eine Kreuzung eingehen, kommt ungefähr ein intermediärer Fertilitätsgrad zustande. Es ist leicht möglich, dass diese Unterschiede auf kleine Differenzen zwischen den homologen Emmergenomen des jeweiligen Emmer- und Dinkelalters zurückzuführen sind.

Im Zusammenhang mit diesem Versuch möchte ich erwähnen, dass ich das Material von *T. persicum* VAV. var. *rubiginosum* ZHUK. (2 Aehren) in Leningrad von Herrn Dr. ZUITIN erhalten habe, neben den

TABELLE 11

Fruchtbarkeit verschiedener pentaploider Bastardverbindungen (in  $F_1$ ) und ihrer Eltern in Kyoto, im Sommer d. J. 1931 (bei Isolierung).

Bastardverbindungen	Zahl d. Aehren	Zahl d. Aehrrchen	Zahl d. Körner		Durchschn. Z. d. Körner pro	
			1-2. Bl.	3. Bl.	Aehre	Aehrrchen (%)
<i>T. rubig.</i> <sup>(1)</sup> × <i>dur.</i>	12	231	210	31	17,500	0,909 (45.5)
<i>T. rubig.</i> × <i>dicoccum</i>	8	148	119	15	14,895	0,804 (40.2)
<i>T. rubig.</i> × <i>turgid.</i>	3	70	77	3	25,666	1,100 (55.0)
<i>T. rubig.</i> × <i>pol.</i>	4	91	60	15	15,000	0,659 (33.0)
<i>T. sp.</i> × <i>turgid.</i>	20	444	606	38	30,300	1,364 (68.2)
<i>T. fulig.</i> <sup>(2)</sup> × <i>vulg.</i>	10	234	273	72+29+4 <sup>(3)</sup>	27,300	1,166 (58.3)
<i>Elterarten</i>						
Emmer						
<i>T. durum</i>	7	128	181	23	25,857	1,414 (70.7)
<i>T. turgidum</i>	10	246	452	20	45,200	1,837 (91.9)
<i>T. fuliginosum</i>	13	247	407	19	31,307	1,647 (82.4)
<i>T. polonicum</i>	9	193	329	21	36,555	1,704 (85.2)
<i>Dinkel</i>						
<i>T. rubiginosum</i>	16	343	595	24	37,187	1,734 (86.7)
<i>T. spelta</i>	20	351	619	0	30,950	1,763 (88.2)

Varietäten *stramineum* ZHUK. und *fuliginosum* ZHUK.<sup>(4)</sup> Bei der Fixierung der PMZ hat sich herausgestellt, dass die beiden letzteren, wie erwartet, 14 haploide Chromosomen hatten, die als var. *rubiginosum* etikettierte Form aber 21. Ob eine Einmischung vorlag, oder ob auch die ganze, als *T. persicum* var. *rubiginosum* bezeichnete Versuchsparzelle irrtümlicherweise mit einer, allerdings *T. persicum* äusserlich sehr ähnlichen *Vulgare*-Varietät besät (oder bepflanzt) war, konnte ich trotz meiner Bemühungen, die Angelegenheit brieflich aufzuklären, nicht feststellen.

(1) Als *T. persicum* VAV. var. *rubiginosum* ZHUK. erhalten.

(2) *T. persicum* VAV. var. *fuliginosum* ZHUK.

(3) Im 3., 4. und 5. Blütenchen.

(4) Ich möchte auch an dieser Stelle Herrn Dr. ZUITIN meinen besten Dank für das Material aussprechen.

## Konkurrenzversuche mit gemischtem Pollen reiner Arten

Diese Versuche habe ich in den Jahren 1925 und 1926 in Berlin-Dahlem, im Kaiser-Wilhelm-Institut für Biologie, ausgeführt. Sie sind in zwei Serien gemacht worden. In einer diente *T. durum* als Mutter, in der anderen *T. vulgare*<sup>(1)</sup>.

Bei der Vorbereitung des Pollengemisches bin ich wie folgt vorgegangen. Ganz reife Antheren von *T. durum* und *T. vulgare* sind, in gleicher Anzahl von beiden Arten, auf ein Uhrschildchen gebracht worden. Nach dem Aufplatzen hat man den Pollen sehr gut gemischt und mit Hilfe einer feinen Pinzette die Narben vorher kastrierter Blüten der beiden Pollenlieferanten mit dem Gemisch reichlich belegt. Auf diese Weise erhielt ich aus dem Versuch *T. durum* × (*durum* + *vulgare*)-Pollen 234 und aus *T. vulgare* × (*durum* + *vulgare*)-Pollen 285 Körner. Sie wurden im J. 1926 alle ausgesät. Nach der Reife ist die Anzahl der Nicht-Bastarde und der Bastarde festgestellt worden. Die Unterscheidung der beiden Typen war ganz einfach und sicher. Die Resultate sind in Tab. 12 zusammengefasst.

TABELLE 12.

Konkurrenzversuche mit gemischtem Pollen (*durum*+*vulgare*) auf den *Vulgare*- und *Durum*-Narben

Kombination	Nicht-Bastard	Bastard	Nicht gekeimt	Summe
<i>Durum</i> × ( <i>durum</i> + <i>vulg.</i> ) %	101 (43,16)	90 (38,46)	41 (18,38)	234 (100)
<i>Vulg.</i> × ( <i>durum</i> + <i>vulg.</i> ) %	248 (87,02)	26 (9,12)	11 (3,86)	285 (100)

Im Versuch *durum* × (*durum* + *vulg.*) sind 101 Nicht-Bastarde und 90 Bastarde gefunden worden. Ziemlich viele Körner haben nicht gekeimt, ca. 18,4%, was nicht etwa auf schlechte Keimung von *T. durum* zurückzuführen war, da von den an den Rändern gleichzeitig ausgelegten *Durum*-Körnern fast alle gekeimt haben.

(1) Das Aussaatmaterial habe ich aus Japan mitgebracht; nähere Angaben betreffs der beiden Arten finden sich in meiner Arbeit "Conjugation of homologous chromosomes in the genus hybrids *Triticum* × *Aegilops* and species hybrids of *Aegilops*" 1929).



Im zweiten Versuch, *vulg.*  $\times$  (*durum* + *vulg.*), waren 248 Pflanzen vom *Vulgare*- und 26 vom Bastard-Typ. Ca. 3,9% Körner haben nicht gekeimt.

Diese Ergebnisse können folgendermassen gedeutet werden.

Bei dem zweiten Versuch mit *vulgare* als Mutter muss der *Vulgare*-Pollen auf der eigenen Narbe in sehr starkem Vorteil gegenüber dem 14-chromosomigen gewesen sein. Diese Annahme ist durch WAKAKUWA's Untersuchungen (vgl. Diskussion, S. 55,59) sichergestellt worden. Aus der kleinen Anzahl nicht gekeimter Körner kann man ferner entnehmen, dass die Keimungsfähigkeit der Bastardkörner in diesem Falle nicht (oder nicht viel) schlechter sein konnte als die der reinen *Vulgare*-Art.

Dagegen bietet der erste Versuch mit *durum* als Mutter ein ganz anderes Bild. Die Anzahl der Nicht-Bastarde und der Bastarde ist nur wenig verschieden. Daraus muss man wohl schliessen, dass die beiderlei Pollenkörner auf der *Durum*-Narbe ungefähr gleich funktionsfähig sind, was auch durch die Versuche von WAKAKUWA bestätigt wurde. Ausserdem fiel hier die bedeutend höhere Anzahl (ca. 18,4%) ungekeimter Körner auf, die, wie vorhin erwähnt, in ganz überwiegender Masse der Bastardkombination gehört haben mussten. Wenn wir einfachheitshalber annehmen, dass alle ungekeimten Körner die Bastardverbindung darstellten, erhalten wir für die beiden Typen, Nicht-Bastard und Bastard, die Prozentzahlen ca. 43,2 und 56,8, was darauf hinweist, dass sogar die 21-chromosomigen Pollenkörner auf der *Durum*-Narbe besser funktionieren als die 14-chromosomigen, arteigenen. Die schlechte Keimung der Bastardkörner muss mit der Beschaffenheit des Endosperms in Verbindung gebracht werden, das bei der Kombination Emmer  $\times$  Dinkel für die Genome A und B triploid ist, aber nur ein einziges D-Genom hat (WATKINS 1929). WAKAKUWA hat bei den reziproken Kreuzungen zwischen verschiedenen Vertretern der beiden Gruppen ganz entsprechende Keimungsverhältnisse beobachtet (vgl. Diskussion, S. 59).

## Diskussion

Durch die vorliegenden Untersuchungen ist die Ansicht von WATKINS (1925, 1930), dass in der Hauptsache das Unbefruchtetbleiben von an sich funktionsfähigen Eizellen für die Sterilität der pentaploiden Verbindungen verantwortlich

zu machen ist, bestätigt worden. Die Elimination von Zygoten, die ich im J. 1924 als die wichtigste Ursache dieser Erscheinung angesprochen habe, ist sicher vorhanden. Sie kann, aber muss nicht, eine sogar beträchtliche Rolle spielen, z. B. wenn eine pentaploide Verbindung infolge ungünstiger klimatischer Bedingungen einen hohen Sterilitätsgrad zeigt. So habe ich bei *T. polonicum*  $\times$  *T. spelta* in Sapporo bei hohem Sterilitätsgrad ca. 24% Zygotenelimination festgestellt, während dieselbe Verbindung in Kyoto, wo die klimatischen Bedingungen für das Wachstum ihrer Pollenschläuche und für die Weiterentwicklung der Embryonen bedeutend besser sind, einen ungefähr viermal so grossen Körneransatz als in Sapporo hervorbrachte und weniger als 5% Zygotenelimination (an einer Pflanze mit  $14_{II}+6_I$  festgestellt) aufwies. Dem Habitus nach zu urteilen, waren in der  $F_2$ -Nachkommenschaft in Kyoto zahlreiche sterile Chromosomenkombinationen vertreten, die in Sapporo fast fehlten.

Es scheint mir danach, dass die Frage nach der Hauptursache der Sterilität dieser Verbindungen mit WATKINS' und meinen jetzigen Untersuchungen in groben Zügen gelöst ist. Der in Frage stehende Erscheinungskomplex bedarf aber selbstverständlich einer näheren Analyse. Bei dem jetzigen Stande der Untersuchungen stehen zunächst zwei Punkte im Vordergrund, nämlich 1. Konkurrenz der Pollenkörner und 2. unerwartet häufiges Auftreten 28- und 35-chromosomiger Individuen in manchen Aequationskreuzungen mit Emmer als Vater. Diese beiden ineinandergreifenden Fragen<sup>(1)</sup> sind in den Einzelheiten noch keineswegs befriedigend analysiert. Wir wollen hier versuchen, zusammenfassend darzustellen, wie weit die bisherigen Untersuchungen vorgeschritten und welche Punkte unklar geblieben sind und weiterer Nachforschung bedürfen.

In bezug auf die Pollenkonkurrenz liegt eine Reihe Versuche vor (Tab. 13). Ueber die ersten Zertationsversuche, die auf sehr kleinen Individuenzahlen fussten, habe ich im J. 1925 berichtet. Diese ergaben, dass in der Kreuzung Dinkel (*T. spelta*)  $\times$   $F_1$  Pollen mit 21 Chromosomen und mit dieser nahestehenden Zahlen in grossem Vorteil ist, während bei Emmer (*T. polonicum*) als Mutter die 14-chromosomigen Pollenkörner ganz überwiegend Nachkommen zu geben schienen (alle 4 Pflanzen waren 28-chromosomig). Auf den ersten Blick schien dieses Resultat nicht schwer zu deuten zu sein; es lag nahe, einen Zusammenhang mit den Chromosomenzahlen des Narbengewebes zu suchen, also

(1) In der Diskussion ist die Pollenkonkurrenz hauptsächlich bei Zertationsversuchen besprochen.

TABELLE 13

Häufigkeit der verschiedenchromosomigen Pollenkörner auf Grund von Zertationskreuzungen

Chromosomenzahl	14	15	16	17	18	19	20	21	Summe
<i>T. spelta</i> × F <sub>1</sub> <sup>(1)</sup> (KIHARA 1925)	0	0	1	0	1	2	3	3	10
<i>T. vulgare</i> × F <sub>1</sub> <sup>(2)</sup> (WATKINS 1927)	6	2	0	1	2	1	4	3	19
<i>T. vulgare</i> × F <sub>1</sub> <sup>(3)</sup> (THOMPSON u. C. 1928)	10	5	4	2	1	2	3	6	33
<i>T. polon.</i> × F <sub>1</sub> (KIHARA 1925)	4	0	0	0	0	0	0	0	4
<i>T. turg.</i> × F <sub>1</sub> (WATKINS 1927)	7	1	0	2	3	1	2	1	17
<i>T. durum</i> × F <sub>1</sub> <sup>(4)</sup> (SAX 1928)	32	11	3	2	4	2	0	2	56
<i>T. dicoccum</i> × F <sub>1</sub> <i>T. durum</i> (THOMPSON u. C. 1928)	33	17	6	6	4	2	3	10	81

ausser der durch die Verschiedenchromosomigkeit der Pollenkörner verursachten Konkurrenz noch eine zweite anzunehmen, die von den als Sieger aus der ersten Konkurrenz ausgegangenen funktionsfähigsten Pollenkörnern aufgenommen würde und zugunsten derjenigen ausfiele, deren Chromosomenzahlen mit den haploiden der Mutter am besten übereinstimmen. Aber schon die von mir im J. 1926 in Berlin ausgeführten Versuche mit gemischtem, 14- und 21-chromosomigem (vgl. S. 52) Pollen ergaben, dass diese Interpretation nur für die Kreuzung *T. spelta* × F<sub>1</sub> zutreffen konnte. Eine weitere Stütze gewann diese Anschauung in der Angabe WAKAKUWA's (1930), der zufolge die Kreuzungen Dinkel × Emmer viel schlechteren Ansatz geben als die reziproken. Meine und WAKAKUWA's Resultate zeigen, dass 14-chromosomige Pollenschläuche auf der Dinkelnarbe in ihrem Wachstum stark beeinträchtigt sind. Die aus der Tab. 13 zu ersiehenden Zertationsversuche mit Dinkel als Mutter

- (1) Emmerelter *T. polonicum*.
- (2) Emmerelter *T. turgidum*.
- (3) Emmereltern *T. dicoccoides* und *durum*.
- (4) Zählungen aus PMZ und Wurzelspitzen zusammengestellt.

anderer Forscher (WATKINS 1927, THOMPSON u. CAMERON 1928) weisen, damit übereinstimmend, jedenfalls auf eine Konkurrenz zwischen 14- und 21-chromosomigen Pollenkörnern zugunsten der letzteren hin<sup>(1)</sup>, nur dass die Verhältniszahlen in allen drei Versuchen sehr verschieden ausfallen.

Hingegen war meine Annahme, dass die Kreuzung Emmer  $\times F_1$  ein Gegenstück zu Dinkel  $\times F_1$  biete und sich auf derselben Grundlage erklären liesse, nicht richtig. Meine Berliner Versuche (vgl. S. 52) haben deutlich gezeigt, dass der 21-chromosomige Pollen auf der Emmernarbe mindestens<sup>(2)</sup> ebenso funktionsfähig ist wie der 14-chromosomige und erregten den Verdacht, das Versuchsergebnis wäre infolge der sehr kleinen Individuenzahl zufällig und irreführend gewesen. Diese Vermutung stützte WAKAKUWA's oben erwähnte Angabe<sup>(3)</sup>. Die entsprechenden Zertationskreuzungen anderer Autoren (WATKINS 1927, SAX 1928, THOMPSON u. CAMERON 1928), die an Hand grösserer Individuenzahlen durchgeführt wurden, bestätigten meinen Verdacht (Tab. 13). Das von SAX angegebene Zahlenverhältnis der 14- zu den 21-chromosomigen Pollenkörnern stimmt besonders gut mit dem erwarteten (15 : 1, wenn mässige Univalentenelimination und etwas grössere Funktionsfähigkeit der 21-chromosomigen Pollenkörner angenommen wird; vgl. Fussn. 1) überein. Im einzelnen fallen auch hier die Verhältniszahlen ziemlich verschieden aus. Welche Faktoren dafür verantwortlich zu machen sind, kann vorläufig nicht gesagt werden; vielleicht findet in verschiedenen Verbindungen eine verschieden starke Univalentenelimination statt.

In manchen Aequationskreuzungen { (*vulgare*  $\times$  *durum*)  $\times$  *durum* } sind auffallend viele 28-chromosomige Individuen aufgetreten. Tabelle 14 bringt die Verhältniszahlen der verschiedenchromosomigen Eizellen der Mutter.

(1) Auch der Versuch von THOMPSON u. CAMERON muss in diesem Sinne gedeutet werden; man darf nicht vergessen, dass das Zahlenverhältnis der 14- und 21-chromosomigen Pollenkörner ohne Konkurrenzwirkung 15:1 ist (bei mässiger Univalentenelimination).

(2) Wenn man den hohen Prozentsatz nicht gekeimter Körner (höchst wahrscheinlich mit dem Endosperm AAABBD) berücksichtigt. Im Endresultat halten sich die Zahlen für Nicht-Bastarde und Bastarde ungefähr das Gleichgewicht (die erstere ist etwas grösser, Tab. 12).

(3) Sowie die laufenden Untersuchungen dieser im grossen Massstab im J. 1930 wiederholten Zertationskreuzung (*T. polonicum*  $\times$   $F_1$ .)



TABELLE 14

Verhältniszahlen der verschiedenchromosomigen Eizellen berechnet aus Aequationskreuzungen (nach WATKINS 1930)

Chromosomenzahl	14	15	16	17	18	19	20	21	Zahl der untersuchten Individuen
THOMPSON u. CAMERON (1928)	0,36	0,14	0,15	0,14	0,10	0,07	0,01	0,02	86
SAX (1928)	0,41	0,20	0,16	0,09	0,07	0,02	0,03	0,02	103

In solchen Fällen kann man wohl nicht umhin, an eine besondere Aktivität der 14-chromosomigen Eizellen (worauf ich auf S. 47 näher eingegangen bin), also an eine selektive Elimination der ♀ Gameten zu denken.

THOMPSON und CAMERON haben aber gleichzeitig, wenn ein anderes *Vulgare*-Elter (*vulgare*-2) zur Verwendung kam, ganz andere Zahlenverhältnisse erhalten, die eine der erwarteten entsprechende Verteilung der verschiedenchromosomigen ♀ Gameten zeigen. Dieses Resultat stimmt mit dem von WATKINS (1927) überein, der bei seinem Aequationskreuzungsversuch einen recht guten Ansatz erzielt hat. Ueber diese Versuche orientiert Tabelle 15.

TABELLE 15

Häufigkeit der verschiedenchromosomigen Eizellen berechnet aus Aequationskreuzungen

Chromosomenzahl	14	15	16	17	18	19	20	21
THOMPSON u. CAMERON (1928)	1	1	5	8	7	3	2	2
WATKINS (1927)	2	4	2	1	1	1	0	0

Den Unterschied zwischen den Resultaten der Tabellen 14 und 15 möchte ich auf den Prozentsatz der angesetzten Körner zurückführen. Der Körneransatz, den THOMPSON und CAMERON in den Versuchen der Tab. 14 erhielten, betrug ungefähr 34% der kastrierten und bestäubten Blütchen; Sax gibt etwa 41% an. In solchen Fällen dürften die nach

unserer Annahme aktiveren 14-chromosomigen Eizellen leichter befruchtet werden, während diejenigen mit intermediären Chromosomenzahlen versagen. Im Versuch von WATKINS (Tab. 15)<sup>(1)</sup> war der Ansatz viel besser (90.5%), wodurch eine mit der erwarteten übereinstimmende Verteilung erzielt wurde. Ein Unterschied in der Aktivität der ♀ Gameten ist also nach meiner Ansicht vorhanden; er ist aber viel schwächer ausgeprägt als bei den ♂ und kommt nur gelegentlich zum Ausdruck.

Der oben ausgesprochenen Voraussetzung folgend, wollen wir nun den Prozentsatz der 14-chromosomigen ♀ Gameten in  $F_1$  ausrechnen, indem wir in die Formel

$$\text{Ansatz (\%)} \times \text{Häufigkeit d. 28-chromosomigen Individuen in der Aequationskreuzung (\%)} = \text{Prozentsatz der 14-chromosomigen Eizellen (\%)}$$

die von THOMPSON und CAMERON und die von SAX angegebenen Zahlen einsetzen. Wir erhalten dann folgenden Prozentsatz der 14-chromosomigen Eizellen:

Für THOMPSON und CAMERON	$34 \times 36 = 12\%$
Für SAX	$41 \times 41 = 16,8\%$

Die von THOMPSON und CAMERON postulierte Zahl kann bei stärkerer Elimination der Univalenten {nach  $(0,73-0,27)^7$ } erhalten werden (ungefähr 11%). Für das Resultat von SAX müssen wir eine noch stärkere Elimination von Univalenten annehmen, um die nötige Anzahl der 14-chromosomigen Eizellen zu erreichen, die dann infolge der von uns vorausgesetzten grösseren Aktivität alle oder fast alle diejenigen sind, die befruchtet werden. Ohne die Hilfsannahme einer Elimination von ♀ Gameten erfordert der Ueberschuss an 28-chromosomigen Pflanzen eine so hohe Univalentenelimination  $\{(0,88+0,12)^7\}$ , wie sie bis jetzt nie gefunden wurde.

Mit diesen Ueberlegungen wäre der Ueberschuss an 14-chromosomigen Eizellen dem Verständnis näher gebracht. Aber wie kann man den sehr bedeutenden Ueberschuss der 21-chromosomigen (der ja umso grösser wird, je stärkere Univalentenelimination angenommen wird) erklären? Dieser Punkt ist vorläufig ganz unverständlich; wahrscheinlich steht er im Zusammenhang mit

(1) Leider geben THOMPSON und CAMERON den in den Versuchen der Tab. 14-15 erzielten Körneransatz nicht getrennt an.

der zur Zeit ebenfalls rätselhaften Flachheit der die betreffenden Zahlenreihen illustrierenden Kurven. Eigentlich weist diese darauf hin, dass die Univalentenelimination in der II. Reifungsteilung, wenigstens in den EMZ, doch nicht ganz zufallsmässig ist (vgl. WATKINS 1930). Die direkten Befunde an den PMZ sprechen allerdings nicht dafür. Die SAX'sche Annahme einer Univalentenelimination "in early embryonic development" scheint mir nicht in allen Fällen anwendbar zu sein.

Es muss aber auch hier berücksichtigt werden, dass die Keimung der mit heteroploiden Chromosomengarnituren ausgestatteten Körner von dem Chromosomensortiment des Endosperms abhängt. Meine Versuche in Berlin im J. 1926 haben bei der Konkurrenzkreuzung *T. durum*  $\times$  (*Durum* + *Vulgare*)-Pollen einen ziemlich hohen Prozentsatz nicht gekeimter Körner gegeben, der, wie ich auf S. 53 erwähnt habe, auf ihre Endospermbeschaffenheit (AAABBBDD) zurückzuführen war. Auch nach WATKINS (1929) ist die Keimung gut, wenn "the extra vulgare chromosomes are all diploid or triploid but bad if some of them are only present in the haploid condition." Die 28-chromosomigen Zygoten kommen dabei natürlich nicht in Frage. Solange die Keimungsverhältnisse bei derartigen Versuchen nicht in jedem Einzelfall genau bekannt sind, können wir über die Rolle dieses Faktors nichts Sicheres aussagen; er darf aber als mitwirkendes Moment (neben der Elimination von Eizellen) bei der Hervorbringung unerwartet vieler 28-chromosomiger Zygoten nicht ausser Betracht gelassen werden. Daraus kann man ersehen, wie ausserordentlich wichtig es ist, sowohl bei Aequations- wie bei Zertationskreuzungen, einen möglichst guten Ansatz zu bekommen und sowohl diesen wie auch den Prozentsatz der gekeimten Körner genau festzustellen.

In diesem Zusammenhang möchte ich erwähnen, dass WAKAKUWA (1930) der von WATKINS ausgesprochenen Annahme weiter nachgegangen ist und den Zusammenhang zwischen den Faktoren: Ansatz, Endospermbeschaffenheit und Keimung bei zahlreichen Verbindungen eingehend untersucht hat. In Kreuzungen zwischen den drei ungleich-chromosomigen *Triticum*-gruppen hat er viel mehr Körner erhalten, wenn die Art mit höherer Chromosomenzahl den Pollen geliefert hat, als umgekehrt. Hingegen war die Keimung im ersten Fall viel schlechter als die der aus der reziproken Kreuzung gewonnenen Körner, womit WATKINS' Resultat bestätigt wurde. Auch WAKAKUWA führt die schlechte Keimung auf die Endospermbeschaffenheit zurück und

kommt zu dem Ergebnis: Die Keimungsunfähigkeit der Körner steigt mit der Anzahl der haploiden Genome im Endosperm. Bei der Kreuzung Einkorn  $\times$  Dinkel, wo die Chromosomengarnitur des Endosperms AAA + B + D ist, konnte er keinen einzigen Keimling erhalten, während in der reziproken 56,8% Keimlinge erzielt wurden.

Ganz ähnliche Verhältnisse liegen bei den Pflanzen mit „sterilen“ Chromosomenkombinationen vor, deren Endospermbeschaffenheit von der normalen, triploiden abweicht. Das Genom D ist hier mehr oder weniger unvollständig, woraus sich eine mangelhafte Keimung ergeben dürfte (vgl. obiges Zitat aus WATKINS). Auf diesen Umstand muss man auch bei der Zygotenemination achten. Unvollständige Genomzusammensetzung des Endosperms und letale „sterile“ Chromosomenkombination des Embryos selbst, das sind die wichtigsten Faktoren, die bei der Zygotenelimination sowohl in embryonalem Zustand wie auch bei der Keimung mit im Spiele sind. Es ist also auch bei Selbstbestäubungen unserer Bastarde von grösster Wichtigkeit, den Körneransatz und den Keimungsprozentsatz zu berücksichtigen.

In bezug auf die im Laufe einiger Generationen sehr rasch vor sich gehende Abnahme der Chromosomenzahlen in der Verminderungsgruppe sei hier noch einiges hinzugefügt. Auch dabei könnte eine grössere Aktivität der 14-chromosomigen ♀ Gameten in Verbindung mit der Tatsache, dass solche in den Folgegenerationen relativ viel häufiger sind als in  $F_1$ , eine grosse Rolle spielen. In manchen Kreuzungen, z. B. *vulgare*  $\times$  *durum*, könnte auch eine stärkere Univalentenelimination mitwirken. Die Keimungsverhältnisse (Endosperm!) bei den 29- bis 34-chromosomigen Pflanzen dürften auch die Erreichung der konstanten Zahl 28 beschleunigen.

Bei allen diesen Ueberlegungen darf nicht übersehen werden, dass das bis jetzt vorliegende Versuchsmaterial für eine statistisch sichere Bearbeitung noch zu klein ist. Für den Ueberschuss an 28-chromosomigen Pflanzen in den Aequationskreuzungen scheint ja meine Erklärung durch Elimination von ♀ Gameten unter Berücksichtigung der Keimungsverhältnisse annehmbar zu sein, während derjenige an 35-chromosomigen vorläufig unverständlich ist. Bei den Untersuchungen der  $F_2$ -Generation begegnen wir Widersprüchen, die vorläufig nicht überbrückbar sind. Meine und MORIYA's (Tab. 8) Resultate sprechen gegen eine auffallend hohe Frequenz von 28-chromosomigen Pflanzen in  $F_2$ , wenn auch bei MORIYA die niedrigen Zahlen deutlich bevorzugt sind und eine stark schiefe Verteilung vorliegt.



Der Versuch von SAX (1923) hingegen zeigt in der Verminderungsgruppe (der Verbindung *vulgare*  $\times$  *polonicum*) eine deutliche Anhäufung in der 28-chromosomigen Klasse (Tab. 3); die Individuenzahl ist aber zu klein, um eine Diskussion auf statistischer Grundlage zu erlauben. Vielleicht verhalten sich verschiedene Verbindungen verschieden (z. B. in bezug auf die Univalentenelimination), vielleicht spielt auch das auf S. 50 erwähnte Moment der Genomdifferenzen eine Rolle dabei. Bevor etwas Bestimmtes darüber ausgesagt werden kann, müssen umfangreiche und an verschiedenen pentaploiden Verbindungen unternommene  $F_2$ - und Rückkreuzungsuntersuchungen ausgeführt werden.

Bis jetzt haben wir in der Diskussion die Vermehrungsgruppe wenig berücksichtigt. Es steht fest, dass 21-chromosomige Pollenkörner bedeutend aktiver sind als die mit 20, 19 u.s.w. Chromosomen. Daher müssen die Pflanzen der Vermehrungsgruppe trotz langsamer Zahlenzunahme, der hier die Univalentenelimination entgegenwirkt, im Laufe der Generationen bei der konstanten Zahl 42 anlangen. In der Vermehrungsgruppe sind noch viel mehr sterile Chromosomenkombinationen zu erwarten als in der Verminderungsgruppe; eben o wie in dieser sind solche Pflanzen hochgradig bis gänzlich steril. Sie werden mit einigen Ausnahmen früher oder später aussterben und verschwinden; solche Ausnahmen bieten bis jetzt die viererlei morphologisch und physiologisch (in bezug auf Sterilität) verschiedenen Zwerge mit  $20_{II}$ , denen je ein d-, ein e-, ein f- und ein g-Paar (der Dinkelchromosomen) fehlt (KIHARA und WAKAKUWA 1930).

Der ganze Chromosomenmechanismus der pentaploiden Bastarde ist, wie wir sehen, darauf eingestellt, die Rückkehr zu den elterlichen Chromosomenzahlen im Laufe der Generationen zu bewerkstelligen. Die Untersuchungen an den pentaploiden Verbindungen lieferten mit ihren Resultaten das erste und wichtigste Tatsachenmaterial für meine Auffassung des Wesens des Genoms; diese verlangt die Vollständigkeit der eine Chromosomengarnitur zusammensetzenden Genome für normale Entwicklung und Fortpflanzungsfähigkeit.

### Zitierte Literatur

- KIHARA, H. 1924. Cytologische und genetische Studien bei wichtigen Getreidearten mit besonderer Rücksicht auf das Verhalten der Chromosomen und die Sterilität in den Bastarden. Mem. Coll. Sci. Kyoto Imp. Univ. B. **1**.
- 1925. Weitere Untersuchungen über die pentaploiden *Triticum*-Bastarde. I. Japan. Journ. Bot. **2**.
- 1929. Conjugation of homologous chromosomes in the genus hybrids *Triticum*  $\times$  *Aegilops* and species hybrids of *Aegilops*. Cytologia **1**.
- 1931. Genomanalyse bei *Triticum* und *Aegilops*. II. *Aegilotriticum* und *Aegilops cylindrica* Ibid. **2**.
- KIHARA, H. und WAKAKUWA, SH. 1930. Über die Zwergpflanzen in der Nachkommenschaft der pentaploiden Verbindung *Triticum polonicum*  $\times$  *Triticum spelta*. (Japanisch) Japan. Journ. Gen. **5**.
- NISHIYAMA, I. 1928. On hybrids between *Triticum spelta* and two dwarf wheat plants with forty somatic chromosomes. Bot. Mag. Tokyo, **42**.
- RENNER, O. 1921. Heterogamie im weiblichen Geschlecht und Embryosackentwicklung bei den *Oenotheren*. Zeitschr. Bot. **13**.
- SAX, K. 1923. The relation between chromosome number, morphological characters and rust resistance in segregates of partially sterile wheat hybrids. Genetics, **8**.
- 1928. Chromosome behaviour in *Triticum* hybrids. Zeitschr. Ind. Abst. u. Vererb.-Lehre Supp. **2**.
- THOMPSON, W. P. and CAMERON, D. R. 1928. Chromosome numbers in functioning germ cells of species-hybrids in wheat. Genetics, **13**.
- THOMPSON, W. P. and HOLLINGSHEAD, L. 1927. Preponderance of *dicoccum*-like characters and chromosome numbers in hybrids between *Triticum dicoccum* and *Triticum vulgare*. Journ. Gen. **18**.
- WAKAKUWA, SH. 1930. Bestäubungs- und Keimungsversuche in reziproken *Triticum*-Kreuzungen. Japanese Journ. Gen. **6**.
- WATKINS, A. E. 1925. Genetic and cytological studies in wheat. II. Journ. Gen. **15**.
- 1927. Idem. III. Ibid. **18**.
- 1930. The wheat species: a critique. Ibid. **23**.

# Untersuchungen über die Bedeutung des Mannits im Stoffwechsel einiger höheren Pflanzen Teil I

Von Toichi ASAI

---

Hierzu 10 Textabbildungen

---

(Eingegangen am 27. Januar 1932)

## Inhalt

I. EINLEITUNG . . . . .	64
II. ÜBER DAS VORKOMMEN VON MANNIT IN HÖHEREN PFLANZEN .	66
III. METHODEN ZUR QUANTITATIVEN BESTIMMUNG VOM MANNIT UND VON KOHLEHYDRATEN . . . . .	69
IV. SCHWANKUNG DES MANNITGEHALTES DER LAUBBLÄTTER EINIGER IMMERGRÜNEN UND LAUBABWERFENDEN BÄUMEN . . . . .	71
(1) Jahreszeitliche Schwankung vom Mannit- und Kohlehydrat- gehalt der Laubblätter von <i>Gardenia jasminoides</i> . . . . .	71
(2) Mannitgehalt der Laubblätter von einigen immergrünen Oleaceen . . . . .	77
(3) Mannitschwankung im Laubblatt eines laubabwerfenden Baums . . . . .	77
V. MANNIT IN EINEM ZWEIJÄHRIGEN KRAUT . . . . .	78
VI. JÄHRLICHE SCHWANKUNG DER KOHLEHYDRATE IM LAUBBLATT EINES ZUCKERSTRAUCHS . . . . .	79
VII. UMWANDLUNG DES MANNITS IN DEN ACHSENORGANEN . . . . .	81
(1) Schwankung des Mannitgehaltes des Zweiges und der Wurzel von <i>Gardenia jasminoides</i> . . . . .	82
(2) Mannit und Kohlehydrate in den Achsenorganen von einigen Oleaceen . . . . .	83
(3) Jahresperiodische Veränderung der Mannit-, Zucker- und Stärkemenge in den Achsenorganen von <i>Punica Grana-</i> <i>tum</i> . . . . .	86
VIII. MANNIT IN BLÜTEN UND SCHOTEN VON <i>Gardenia jasminoides</i> .	88
IX. ZUSAMMENFASSUNG . . . . .	90
X. ZUSAMMENSTELLUNG DER TABELLEN . . . . .	92

## I. Einleitung

Der sechswertige Alkohol Mannit ist ein Pflanzenstoff, der in niederen und höheren Gewächsen weit verbreitet vorkommt,<sup>(1)</sup> aber wir sind bisher sehr wenig unterrichtet über die Rolle, welche dieser und verwandte Zuckeralkohole im Stoffwechsel der grünen Pflanzen spielen, obzwar, von rein biochemischem Gesichtspunkte aus betrachtet, keine Schwierigkeit im Wege steht, die gegenseitige Umwandelbarkeit von Hexiten und Hexosen anzunehmen.

Der reichliche Mannitgehalt der Hutpilze hat schon früh die Aufmerksamkeit von Forschern erweckt, und man zweifelte nicht daran, dass der Mannit dort als wichtigster Reservestoff neben Trehalose fungiert, welche letztere übrigens, nach BOURQUELOT,<sup>(2)</sup> unter gewissen Bedingungen sehr schnell in den ersteren übergeht. Die vorzügliche Verwendbarkeit des Mannits in Bau- und Betriebsstoffwechsel von Schimmelpilzen, Hefen und Bakterien wurde vielfach konstatiert,<sup>(3)</sup> und auch das Auftreten dieser Substanz als Gärungsprodukt einiger Bakterien bildete öfters den Gegenstand näherer Untersuchungen, obwohl man bisher daraus keinen tieferen Einblick in Chemismus aller dieser Vorgänge abzugewinnen vermochte. Neuerdings hat K. KINOSHITA<sup>(4)</sup> die interessante Beobachtung gemacht, dass eine neue *Aspergillus*-Art, *A. itaconicus*, Mannit aus Rohrzucker und Lävulose bildet und reichlich in sauer reagierende Kulturlösung ausscheidet. Das Vorkommen von Mannit in verschiedenen Flechten von ZOFF,<sup>(5)</sup> und dasselbe in Laminariaceen und anderen Braunalgen wurde zuerst von STENHOUSE<sup>(6)</sup> und später von KYLIN<sup>(7)</sup> sichergestellt.

(1) PROUST, Ann. de Chim., **57**, 1806, 131; BRACONNOT, Ann. de Chim., **79**, 1811, 265; VAUQUELIN, Ann. de Chim., **85**, 1813, 5; A. MUNTZ, Ann. de Chem. et Phys. **8**, 1876, 56; Ber d.d. chem. Ges., **7**, 1874, 1788; W. THÖRNER, Ber. d.d. chem. Ges., **12**, 1879, 1635; GAZE, Archiv d. Pharmazie, **243**, 1905, 78; Chem. Centralbl. **1**, 1905, 924 (*Lycoperdon*).

(2) E. BOURQUELOT, Bull. Soc. Mycol. **5**, 1889, 34, 132; **6**, 1890, 150, 185; **7**, 1891, 50; **8**, 1892, 13.

(3) STRECKER, Lieb. Ann., **92**, 1854, 80; U. GAYON u. E. DUBOURG, Ann. Inst. Pasteur, **8**, 1894, 108; **15**, 1901, 527; MÜLLER-THURGAU u. OSTERWALDER, Zentr. Bakt., II, **36**, 1912, 129; W. H. PETERSON u. Mitarbeiter, Journ. Biol. Chem., **39**, 1919, 349; **41**, 1920, 431; **42**, 1920, 373; F. OBATON, Rev. gén. bot., **41**, 1930, 282.

(4) Acta Phytochim., **5**, 1931, 276.

(5) ZOFF, Annalen d. Chemie u. Pharmazie, **364**, 1902, 253; Chem. Centralbl., **1**, 1909, 125.

(6) J. STENHOUSE, Lieb. Ann., **51**, 1844, 349.

(7) H. KYLIN, Ztsch. physiol. Chem., **83**, 1913, 174.



Was speziell bisherigen Nachweis vom Mannit in verschiedenen höheren Pflanzen anbelangt, so war derselbe immer von gelegentlicher Natur und zwar wurde meistens von Chemikern und Pharmazeuten bald an diesen, bald an jenen Pflanzenteilen ausgeführt.<sup>(1)</sup> Man konnte deshalb kaum eine einigermaßen klare Vorstellung von der Verteilung dieser Substanz in verschiedenen Pflanzenteilen machen, geschweige denn von deren Bildung und Umwandlung im Pflanzenkörper.

Eine bisher einzig dastehende Arbeit über diesen Gegenstand rührt von F. OBATON<sup>(2)</sup> her. Er fand bei *Apium graveolens* im Anfang Oktober den Höchstgehalt der Laubblätter an Mannit sowie an Zucker und er betrachtet nur deshalb den Mannit als ein Assimilationsprodukt. In unterirdischen Teilen von *Apium* sammelt sich der Mannit im ersten Jahre der Vegetation. Im Winter soll der Mannit dort abnehmen, während sich die Rohrzuckermenge vergrößert. Beim Wachstumsvorgang am zweiten Jahre findet der Mannit keine merkliche Verwendung. OBATON begnügte sich dabei mit blosser Bemerkung: „le polyol n'est donc pas une substance de déchet.“

Als ich vor mehreren Jahren im botanischen Institute zu Tokyo arbeitete, hatte ich in Gemeinschaft mit M. NAKAMURA gefunden<sup>(3)</sup>, dass der Mannit in Blütenblättern von *Gardenia jasminoides* ELLIS, einem immergrünen Strauch aus der Familie Rubiaceae, reichlich vorkommt, und ferner, dass die Laubblätter nur in kalten Jahreszeiten diesen Stoff enthalten. Auf Anregung von Herrn Prof. K. SHIBATA habe ich dann nach meiner Übersiedelung in Kumamoto die eingehende quantitative Untersuchung über diese interessante Erscheinung jahrelang fortgesetzt, um in erster Linie festzustellen, ob und in wie weit die erwähnte Periodizität in der Bildung und Anhäufung von Mannit in verschiedenen Vegetationsorganen und auch in anderen mannithaltigen Pflanzen zu konstatieren sei. Dabei wurde eine besondere Beachtung dem innigen Zusammenhang von diesem Vorgang mit der jahreszeitlichen Schwankung in Stärke- und Zuckergehalt der Pflanzen geschenkt.

Auf diese Weise gelang es mir hier zum ersten Male eine zusammenhängende Darstellung von zeitlichem und räumlichem Auftreten eines Zuckeralkohols in höheren Gewächsen zu geben und seine physiologische Bedeutung in Beziehung zum Kohlehydratstoffwechsel gewissermaßen aufzuklären.

(1) Vergl. hierzu C. WEHMER, Die Pflanzenstoffe, I u. II, 1929-1931.

(2) Rev. gén. bot., **41**, 1929, 555.

(3) T. ASAI u. M. NAKAMURA, Botan. Magaz., Tokyo, **33**, 1919, 71.

## II. Ueber das Vorkommen von Mannit in höheren Pflanzen

Aus den bisherigen Literaturangaben kann man etwa folgende Vorkommnisse von Mannit in Samenpflanzen verzeichnen, mit Ausnahme von einigen Baumflusssäften, wie Eschenmanna, an welchem zwar die erste Entdeckung dieser Substanz gemacht wurde.

### Laubblätter

Umbelliferae :	<i>Aethusa Canapium</i>
	<i>Apium graveolens</i>
Oleaceae :	<i>Fraxinus excelsior</i>
	<i>Jasminum officinale</i>
	<i>Ligustrum vulgare</i>
	<i>Olea europaea</i>
	<i>Syringa vulgaris</i>
Scrophulariaceae :	<i>Linaria vulgaris</i>
Rubiaceae :	<i>Gardenia jasminoides</i> (G. florida)
	<i>Genipa brasiliensis</i>
Palmae :	<i>Cocos nucifera</i>

### Rinde

Platanaceae :	<i>Platanus orientalis</i>
Winteranaceae :	<i>Canella alba</i>
	<i>Warburgia Stuhlmannia</i>
Oleaceae :	<i>Fraxinus excelsior</i>
	<i>Fraxinus Ornus</i>
	<i>Jasminum officinale</i>
	<i>Ligustrum vulgare</i>
	<i>Phillyrea latifolia</i>
Myoporaceae :	<i>Myoporum platycarpum</i>
Rubiaceae :	<i>Basanacansa spinosa</i>
	<i>Genipa brasiliensis</i>

### Wurzel

Ranunculaceae :	<i>Aconitum Napellus</i>
Leguminosae :	<i>Glycyrrhiza glabra</i>
Punicaceae :	<i>Punica Granatum</i>
Umbelliferae :	<i>Apium graveolens</i>
	<i>Daucus carota</i>
	<i>Meum athamanticum</i>
	<i>Oenanthe crocata</i>
Primulaceae :	<i>Cyclamen europaeum</i>
Compositae :	<i>Scorzonera hispanica</i>
Gramineae :	<i>Agropyrum repens</i>
	<i>Andropogon annulatus</i>

## Früchte

Gnetaceae :	<i>Ephedra distachya</i>
Lauraceae :	<i>Laurus persea</i>
Rosaceae :	<i>Prunus Laurocerasus</i>
Cactaceae :	<i>Cactus opuntia</i>
Oleaceae :	<i>Olea europaea</i>
Rubiaceae :	<i>Coffea arabica</i>
Bromeliaceae :	<i>Ananas sativus</i>

Wie man aus obiger Aufzählung, die aber keine Vollständigkeit beanspruchen kann, ersieht, kommt der Mannit ziemlich weit verbreitet in höheren Pflanzen aus verschiedenen Verwandtschaftskreisen vor.

Um einiges über das Vorkommen dieser Substanz bei einheimischen Gewächsen zu erfahren, habe ich zunächst die nachfolgende qualitative Probe angestellt.

Je 5 g des fein zerschnittenen frischen Materials werden mit 50 ccm 25 % Alkohol in ein grosses Reagenzglas gebracht, auf dem Wasserbad 30 Minuten gekocht und dann noch heiss filtriert. Die Flüssigkeit dampft man zur Trockne ab. Der Rückstand wird mit 20 ccm warmen 90 % Alkohol extrahiert und nach dem Erkalten in ein Reagenzglas filtriert. Bei mehr als eine Woche langem Stehen kristallisiert der Mannit in charakteristischen Nadelchen und Prismen und zwar fast sämtlich an der Wand des Probierrohrs, sodass man seine Menge leicht abschätzen kann. Die Resultate sind in Tab. I zusammengestellt.

TABELLE I

Pflanze	Versuchszeit	Mannitgehalt			
		Blatt	Rinde	Holz	Blüte
<i>Punica Granatum</i>	6. Feb.		++	++	
	5. Juni				+
	17. Juni	+	+	+	
<i>Jasminum nudiflorum</i>	16. März		++	+	+
	15. Juli	+	+	+	
<i>Jasminum odoratissimum</i>	6. Feb.	+	++	+	
	11. Mai				+
	15. Juli	+	+	+	
<i>Ligustrum Ibota</i>	6. Feb.		+	+	
	31. Mai				+
	10. Juni	+	+	+	

TABELLE I (Fortsetzung)

Pflanze	Versuchszeit	Mannitgehalt			
		Blatt	Rinde	Holz	Blüte
<i>Ligustrum japonicum</i>	6. Feb.	+	++	+	
	31. Mai				+
	10. Juni	—	+	+	
<i>Osmanthus aquifolius</i>	9. Feb.	+	++	+	
	10. Juni	—	+	+	
	1. Nov.				+
<i>Osmanthus fragrans</i>	6. Feb.	++	++	+	
	10. Juni	—	+	+	
	11. Okt.				+
<i>Gardenia jasminoides</i>	6. Feb.	+++	+++	++	
	27. Juni		—		++
	15. Juli	—		—	
<i>Gardenia florida</i> (flore pleno)	9. Feb.	+++	+++	++	
	3. Juli				++
	15. Juli	—	—	—	
<i>Gardenia radicans</i>	6. Feb.	+++	+++	++	
	3. Juli				++
	15. Juli	—	—	—	

Wie aus obiger Zusammenstellung ersichtlich, zeigen besonders die Rinden und immergrünen Laubblätter Mehrgehalt an Mannit im Winter als im Sommer. Am auffallendsten tritt diese Erscheinung zu Tage, wie schon eingangs erwähnt, bei *Gardenia jasminoides* und ihren Verwandten, wobei der Mannit in warmen Jahreszeiten aus allen Vegetationsorganen gänzlich verschwindet. Andere 77 zum Vergleich herangezogene, zumeist immergrüne Pflanzen, die Pteridophyten, Gymnospermen, Mono- und Dicotylen umfassen, erwiesen sich bei obiger Probe durchgehends mannitfrei. Auch bei *Forsythia suspensa* aus Oleaceae und *Serissa foetida* aus Rubiaceae konnte ich keinen Mannit auffinden.

Meine nachstehend beschriebenen quantitativen Untersuchungen beziehen sich also hauptsächlich auf *Gardenia*, *Punica* und einige oben angeführte Oleaceen.



### III. Methoden zur quantitativen Bestimmung vom Mannit und von Kohlehydraten

Da uns keine einfachere analytische Methode zur Bestimmung von Mannit bekannt war, so musste ich zur zeitraubenden und mühseligen Prozedur greifen, denselben jedesmal aus Untersuchungsobjekten in Substanz abzuschneiden und zur Wägung zu bringen. Sie benötigte naturgemäss immer eines ziemlich grossen Aufwandes an Pflanzenmaterial, was aber andererseits uns den Vorteil bot, dass man damit leicht zu zuverlässigen Durchschnittswerten gelangen konnte.

200 g frischen zerkleinerten Pflanzenmaterials werden mit 1 Liter 25 % Alkohol 1 Stunde am Rückfluss auf dem Wasserbade erhitzt, heiss koliert und der Rückstand nochmals mit 1 Liter warmen Wasser extrahiert. Die vereinigten Auszüge werden unter fortwährendem Umschütteln mit so viel basischer Bleiacetatlösung versetzt, bis kein Niederschlag mehr entsteht, und dann von gelber Fällung abfiltriert. Die Flüssigkeit wird mit  $H_2S$  entbleit, neutralisiert und nochmals filtriert. Man dampft das Filtrat bis auf ca. 40 ccm ein, und stellt es an einem kühlen Ort. Nach einigen Tagen werden die ausgeschiedenen Mannitkristalle abgesaugt und mit wenig 90 % Alkohol gewaschen. Die Mutterlauge wird noch einigemal für weitere Kristallisationen verarbeitet. Die Gesamtmengen Kristalle werden zur Gewichtskonstanz getrocknet und gewogen. Man nimmt ferner mit gereinigten Kristallen die Schmelzpunkt-Probe vor. Der Mannitgehalt wird auf das Trockengewicht des Materials berechnet.

Zur Bestimmung des Kohlehydratgehaltes wird das frisch gesammelte Material zunächst im Trockenschrank bei 90° C. rasch getrocknet, zum feinen Pulver gemahlen und bei 100° C. zum konstanten Gewicht gebracht.

Eine abgewogene Menge (ca. 2 g) Pulver wurde in einen 250 ccm fassenden Kolben eingetragen, darauf wurden 0,1 Calciumcarbonat und 150 ccm Wasser hinzugesetzt; der Kolben wurde eine Stunde lang in einem siedenden Wasserbade gestellt. Nach dem Abkühlen wurde der Inhalt auf 200 ccm mit Wasser ergänzt und gut umgeschüttelt. Die Extraktionsflüssigkeit wurde durch ein Filtrierrohr mit Asbest klar filtriert. Mit 25 ccm dieses Filtrates wird der reduzierende Zucker nach BERTRAND bestimmt und als Glucose berechnet. Zur Inversion wurden 25 ccm Flüssigkeit mit 2 ccm Salzsäure von spez. Gew. 1,125 versetzt und 30 Minuten auf 70° C. erhitzt. Nach dem Neutralisieren mit Sodalösung wurde der Invertzucker nach BERTRAND bestimmt und in Rohrzucker umgerechnet.

Um die Stärke zu bestimmen, wurde der obige Extraktionsrückstand wiederholt mit lauwarmem Wasser gewaschen und mitsamt Filterasbest in einen Kolben gebracht. Darauf wurden 50 ccm Wasser mit 0,2 g Weinsäurezusatz hinzugefügt und eine Stunde lang im Autoklaven bei 143° C. erhitzt. Nach dem Abkühlen wurde der Kolbeninhalt mit Wasser auf 200 ccm aufgefüllt und klar filtriert. 100 ccm Filtrat wurden dann mit 15 ccm 25 % Salzsäure versetzt, 3 Stunden auf dem Wasserbad gekocht, danach mit Sodalösung neutralisiert und wieder mit Wasser auf 200 ccm ergänzt. Mit 25 ccm dieser Lösung wurde die Zuckerbestimmung ausgeführt, woraus man die Stärkemenge berechnete.

Als man bei obiger Prozedur die Bleiacetatbehandlung des Extraktes unterliess, so wurden gewisse Mengen reduzierender Substanzen wie Gerbstoffe und Glykoside mitbestimmt, was aber in meisten Fällen, wie Kontrollanalysen zeigen, keinen für unseren Zweck schwer ins Gewicht fallenden Fehler verursachte.

Wenn nötigenfalls die Bleizuckerbehandlung vor der Zuckerbestimmung zur Verwendung kam, wurde das ganze Pflanzenextrakt aus dem pulverisierten Material (2 g) auf 200 ccm mit Wasser ergänzt und mit dem Asbestfilter filtriert. Nun wurden 100 ccm des genau abgemessenen Filtrats mit genügender Menge Bleizuckerlösung behandelt, der entstandene Niederschlag wurde abfiltriert und wiederholt ausgewaschen, worauf das Filtrat samt Waschwasser auf 200 ccm aufgefüllt wurde. Danach wurde  $H_2S$  in diese Lösung eingeleitet, um den überschüssigen Bleizucker zu entfernen, je 25 ccm der so bereiteten Flüssigkeit wurden neutralisiert und zur Zuckerbestimmung gebraucht. Einige Beispiele aus Analysenresultaten folgen :

TABELLE II

Laubblätter von	Extrakt unmittelbar gebraucht		Extrakt mit Bleizucker behandelt	
	pro 100 g Trockengew.			
	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g
<i>Gardenia jasminoides</i>	3,64	2,95	2,44	2,97
<i>Punica Granatum</i>	18,96(1)	0	16,43(1)	0
<i>Daphne odora</i>	9,97	7,82	6,78	7,87

Die Laubblätter wurden am 18. Mai gesammelt.

(1) Wie viel vom hier als Glucose berechneten Reduktionswert wirklich derselben zukommt, bleibt dahingestellt.

#### IV. Schwankung des Mannitgehaltes der Laubblätter einiger immergrünen und laubabwerfenden Bäume

Wie bereits erwähnt, ist der Mannit ziemlich weit im Pflanzenreich verbreitet, zuweilen wird er in den Vegetationsorganen von verschiedenen höheren Pflanzen in beträchtlichen Mengen und in gewissen Fällen sogar reichlicher als Zuckerarten vorgefunden. Trotzdem ist seine Rolle im Stoffwechsel der Pflanzen noch gar nicht klargestellt, so dass vor allem eine eingehende Darstellung seiner physiologischen Verhalten zu verschiedenen Vegetationsperioden sehr wünschenswert erscheint.

Um eine gewisse Einsicht in diese Frage zu gewinnen, habe ich zunächst im Sommer, vom Juni bis Ende August, den Mannit in den jungen, der erwachsenen und den vorjährigen, schon vergilbenden Laubblättern von *Gardenia jasminoides* nachzuweisen versucht, aber der Befund war stets negativ, keine Spur davon war aufzufinden. Darauf habe ich im März und Dezember die gleichen Versuche angestellt, wobei die Laubblätter alle vier Stunden vom Tagesanbruch bis in die Nacht gesammelt wurden. In diesen Fällen trat der Mannit immer reichlich in den Laubblättern auf, an Menge kaum den Zuckerarten nachstehend.

Die obigen vorläufigen Beobachtungen veranlasste mich, den Mannitgehalt der Laubblätter dieser Pflanze von Monat zu Monat, vom jüngsten Entfaltungsstadium bis zum Laubfall, genauer zu bestimmen und seine jahreszeitliche Veränderung näher zu verfolgen. Auf die Aufklärung harreten auch die Fragen, ob der Vorgang sich ähnlich bei anderen immergrünen sowie laubabwerfenden Mannitbäumen abspielt, und ferner, ob und wie sich die gegenseitige Beziehung zwischen dem Mannit und den üblichen Assimilaten bei der Stoffumwandlung gestaltet.

##### (1) Jahreszeitliche Schwankung vom Mannit- und Kohlehydrat-Gehalt der Laubblätter von *Gardenia jasminoides*

Die Winterknospe von *Gardenia jasminoides* ist schon im Dezember 1 cm lang hervorgeschossen, am Ende April vergrößert sich zu 2 cm

und fängt aufzubrechen an. Gegen Mitte Juni treibt der neue Spross mit jungen Laubblättern, und häufig gehen auch die Sommerknospen nach der Blüte auf. Gerade zu jener Zeit, wo die Laubknospen sich entfalten, vergilben viele ältere Blätter und fallen schnell ab, aber um Mitte Juli beobachtet man die vergilbten Laubblätter nur selten an Zweigen. Sie vermehren sich wieder im Herbst in auffallender Weise und hören erst am Anfang November mit dem Abfallen beinahe auf. Also dauert der normale Lebenslauf eines Laubblattes von *Gardenia* von der ersten Entfaltung im Juni zum November nächsten Jahres; die schon im Juni vergilbenden Blätter sind vielleicht diejenigen aus den Sommerknospen des vorletzten Jahres.

Am 20. Juni wurde die Gewichtsbestimmung der Laubblätter von verschiedenen Entwicklungsstadien und Grössen ausgeführt. (Tab. III.)

TABELLE III

Blattgewicht von wild wachsender *Gardenia jasminoides*

Blätter	gross		mittelgross		klein	
	Frischgew. in g	Trocken- gew. in Proz.	Frischgew. in g	Trocken- gew. in Proz.	Frischgew. in g	Trocken- gew. in Proz.
jung	0,303	24,71	0,132	30,23	0,039	29,14
erwachsen	1,736	37,43	0,795	39,60	0,275	40,23
vergilbt	1,095	35,76	0,555	38,82	0,224	39,79

Die Zahlen sind die Durchschnittswerte von je 5 Exemplaren.

Zu dieser Jahreszeit konnte ich Mannit in keinen untersuchten Exemplaren nachweisen, sodass die Entwicklungsstadien und Alter der Laubblätter für die Frage der Mannitbildung keine Bedeutung haben.

Es fragt sich nun, ob die Mannitbildung in Laubblättern als die Folge der Kohlensäure-Assimilation eintritt.

Die Laubblätter wurden alle drei Stunden von kurz vor Tagesanbruch bis in die Nacht gesammelt und der quantitativen Mannitbestimmung nach der oben beschriebenen Methode unterworfen.



Gerade in der Mitte des Sommers, wo die Assimilationstätigkeit der Gewächse am lebhaftesten vor sich geht, bleibt der Mannitgehalt des Laubblattes ungeachtet der günstigen Belichtungsverhältnisse stets null. Im Winter ist der Mannit zu jeder Tageszeit reichlich in den Laubblättern nachzuweisen, aber sein Gehalt zeigt im Laufe eines Tages bedeutende Schwankung weder beim im Baumschatten wachsenden Stock noch beim an sonniger Stelle angepflanzten, wie es aus der Kurvendarstellung in Fig. 1 hervorgeht.

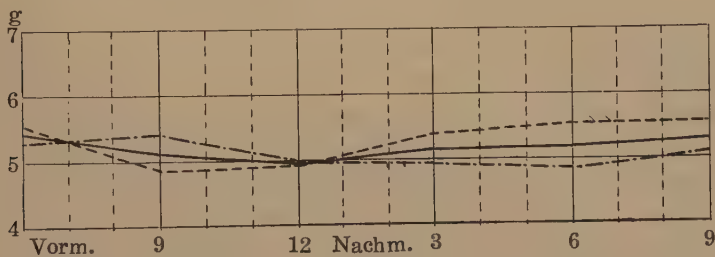


Fig. 1. Die Kurven des Mannitgehaltes der am 10. Dezember jede 3 Stunden gesammelten Blätter. Auf der Abszissenachse stehen Tagesstunden und die Ordinaten geben die Mannitmenge in g pro 100 g Trockensubstanz ... bei der wild wachsenden *Gardenia*, — bei der kultivierten, — Mittel der beiden

Bei wildwachsender *Gardenia* liegt der mittlere Gehalt an Mannit am Versuchstage bei 5,32 g für 100 g Blatt-Trockensubstanz und beträgt die Differenz zwischen tagesmaximaler und -minimaler Menge bei 0,76 g (siehe Tab. VII, 1, S. 92); bei dem Kulturstock sind auch die angegebenen Werte 5,12 g bzw. 0,65 g (Tab. VII, 2).

Es bleibt einstweilen dahingestellt, ob man diese bald früh, bald spät am Tage eintretende Mannitzunahme dennoch als die Folge der Photosynthese betrachten darf. Im winterlichen Zustand zeigt auch der Stärke- und Zuckergehalt von *Gardenia*-Blättern im Laufe eines Tages eine nur geringe oder kaum merkliche Zunahme, die den Assimilationsgewinn ausmacht. Zum Vergleich wurden einige krautige und holzige Gewächse mit überwinternden Laubblättern in dieser Hinsicht untersucht, und nur in einem Falle (*Brassica campestris*) eine deutliche Zunahme an reduzierenden Zucker durch Assimilation beobachtet; der Stärkegehalt blieb zu verschiedenen Tagesstunden beinahe unverändert (Tab. VIII, 1, 2, 3, 4).

Wir wenden uns nun auf die Frage, ob und wie die Laubblätter von *Gardenia* eine jahreszeitliche Veränderung in deren Mannitgehalt aufweisen. Es wurden die Mannit-, Zucker- und Stärkebestimmung einmal monatlich ausgeführt, vom Juni bis zum Oktober des nächsten Jahres, also während des ganzen Lebenslaufs eines Laubblattes. Die Materialnahme erfolgte am bestimmten Tage um Mitte jedes Monates und zwar immer an selber Tagesstunde. Die Ergebnisse der Analysen sind in Tab. IX zusammengestellt und in Fig. 2 graphisch dargestellt. In der Tabelle ist auch die Blatttrockensubstanz in Prozenten des Frischgewichtes angegeben, woraus sich der jeweilige Wassergehalt leicht ersehen lässt.

Bei *Gardenia jasminoides* tritt der Mannit in den erwachsenen Laubblättern zuerst im Oktober (bei 17,3°C. Monatsmittel) auf, zu 1 g für 100 g Trockensubstanz. Der Gehalt steigt von Oktober bis Dezember mit mehr als 2% monatlicher Zunahme auf, also nimmt die Mannitbildung zwischen Oktober und November den grössten Aufschwung. Dieser Zuwachs verringert sich zwar mit der Zeit, aber an der Mitte Februar erreicht der Mannitgehalt schliesslich mit 8,05% das Jahresmaximum. Ende Januar bis Mitte Februar ist die kälteste Zeit des Jahres in der Gegend Kumamoto, SüdJapan, wie in folgender Tabelle IV gezeigt:

TABELLE IV

Die Lufttemperatur in Kumamoto (1891–1925)

	Jan.	Feb.	März	Apr.	Mai	Juni	Juli	Aug.	Sept.	Okt.	Nov.	Dez.
Monatsmittel	4,7	5,3	9,0	14,6	18,4	22,3	26,1	27,0	23,6	17,3	11,3	6,2
Höchstes Tagesmittel	10,4	11,0	14,9	20,6	24,5	27,1	31,0	32,4	29,0	23,7	17,9	12,3
Niedrigstes Tagesmittel	-0,8	-0,1	3,1	8,3	12,2	17,8	21,9	22,3	18,8	11,4	5,3	0,6
Höchstes Monatsmittel	17,7	18,9	22,2	26,5	29,6	31,8	34,7	35,2	33,7	28,7	24,6	19,7
Niedrigstes Monatsmittel	-6,3	-6,0	-3,6	0,6	5,4	11,7	18,0	18,9	12,1	4,6	-1,4	-5,0

Vom Februar zum März fällt die Kurve des Mannitgehaltes mit 4,43% Abnahme steil ab und der Mannit vermindert sich noch weiter, bis er im Mai gänzlich aus Laubblättern verschwindet. Wir können ferner die Veränderung des monatlichen Mannitgehaltes der Laubblätter in folgender Tabelle V anschaulich darstellen:

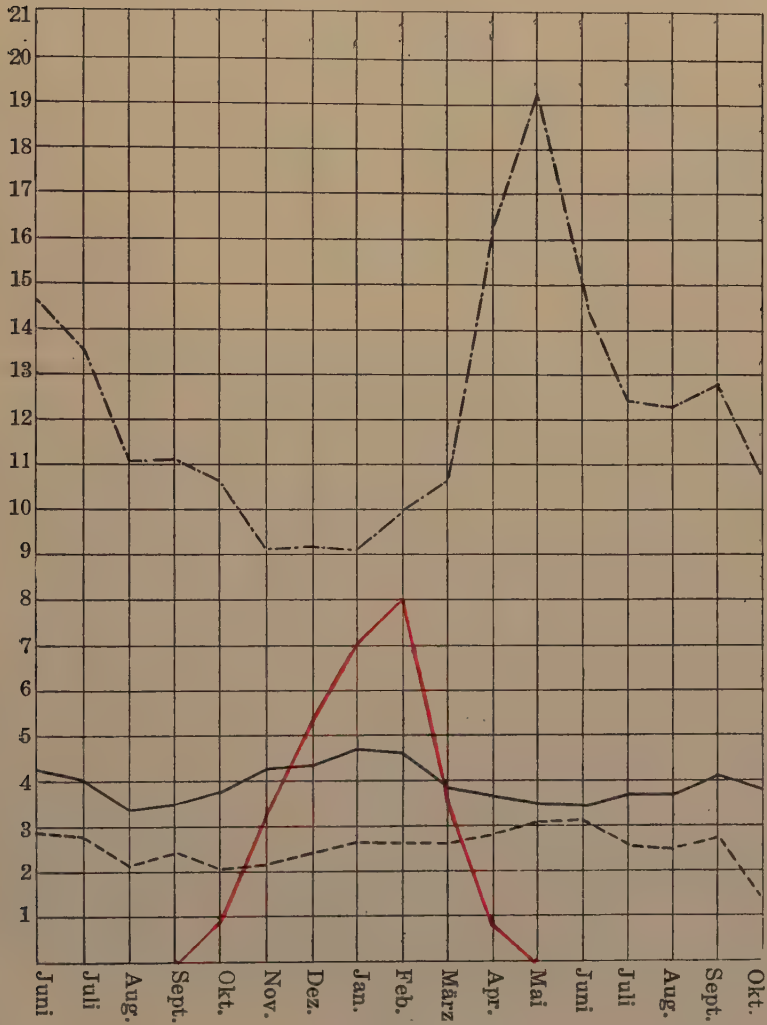


Fig. 2.—Jahreszeitliche Schwankung der Zucker-, Stärke- und Mannitmenge in den Laubblättern von *Gardenia jasminoides* in ihrem ganzen Lebenslauf. Die Ordinaten geben die Menge der Substanzen in g für 100 g Blatttrockengewicht und auf der Abszissenachse stehen die Monate. — Reduzier. Zucker, ..... nichtreduzier. Zucker, —.—.— Stärke und — Mannit

TABELLE V

Zu- oder Abnahme des Mannitgehaltes der Laubblätter in jeden  
nachfolgenden Monaten

	Sep.	Okt.	Nov.	Dez.	Jan.	Feb.	März	Apr.	Mai
pro 100 g Trockengew. in g.	1,02	2,41	2,10	1,56	0,97	-4,43	-2,82	-0,80	
pro 1 qm Blattfläche in g.	0,93	2,20	1,94	1,41	0,82	-3,94	-2,65	-0,71	

Die Zuckermenge in den Laubblättern von *Gardenia jasminoides* schwankt im Laufe eines Jahres nur in mässigem Grade, innerhalb der Grenze 3,40–4,73% an reduzierendem Zucker, und 1,46–3,20% an nicht-reduzierendem Zucker (siehe Fig. 2). Die Kurve des reduzierenden Zuckers in jungen Laubblättern fällt bis zum Jahresminimum von 3,40% im August ab, dann steigt sie allmählich bis zum Januar auf, um wieder nach und nach herunterzugehen. Auch die Mengenveränderung des nichtreduzierenden Zuckers hält im ersten Jahre einen beinahe gleichen Schritt wie der vorige, die Menge nimmt sehr allmählich vom August zu, erreicht einen maximalen Wert von etwa 3% im Mai und Juni des nächsten Jahres und geht dann bis zum Laubfall herunter. Hingegen tritt die Stärke in doppelt so grosser Menge wie Gesamtzucker in allen Monaten, ausgenommen die kältere Jahreszeit, auf. Stärke kommt in jüngsten Laubblättern im Juni schon zu einer Menge 14,49% vor, fällt mit rascher Abnahme bis zum Jahresminimum von ca. 9% im November-Januar ab, danach fängt sie vom Februar sich zu vermehren an, erreicht durch die plötzliche Zunahme am April den auffallenden maximalen Gehalt von 19,32% im Mai und vermindert sich wieder rasch bis zum nächsten August. Aber Stärke bleibt in vergilbten Blättern im Oktober noch zu etwa 11% übrig (Tab. IX u. Fig. 2).

Aus dem gesagten geht es klar hervor, dass reduzierender und nichtreduzierender Zucker in den Laubblättern von *Gardenia* selbst in kältester Zeit, wo sie zum Maximalgehalt kommen, nicht die Menge von 5% überschreiten, und jahreszeitlich nur mit etwa 1% Abweichung schwanken. Dieser geringen Veränderung der Zuckermenge entgegen, wandeln sich Mannit und Stärke mit etwa 10% Abweichung jahreszeit-



lich um, jedoch stehen die Ab- und Zunahme dieser beiden Stoffe zu einander immer im ganz umgekehrten Verhältnis.

Es wurden auch die Laubblätter der zwei anderen Arten von *Gardenia* mit gefüllten Blüten im Winter und Sommer auf ihren Mannit- und Kohlehydrat-Gehalt vergleichend untersucht. Im Sommer ist der Mannit dabei gleichfalls gänzlich verschwunden. Allein im Winter ist er in erheblicher Menge enthalten, insbesondere bei *Gardenia florida*, die im Januar mehr als 9% Gehalt zeigt. Gleichzeitig enthält diese Art 2-3% mehr nichtreduzierenden Zucker, dagegen 2-3% weniger Stärke als andere verwandte Arten. (Vergl. Tab. X, 1 u. 2).

## (2) Mannitgehalt der Laubblätter von einigen immergrünen Oleaceen

*Jasminum odoratissimum* ist ein zu den Oleaceen gehörender immergrüner Baum, aber seine Laubblätter sind nicht besonders hart und werden in dieser Gegend öfters durch Frost beschädigt. In jungen Laubblättern befindet der Mannit sich nur spurenweise, vermehrt sich dann allmählich und erreicht Mitte Juni einen mehr als 1% Gehalt, aber selbst im Winter weist seine Menge keine erhebliche Steigerung auf.

Die Laubblätter von *Osmanthus fragrans* entfalten sich im April, und enthalten schon den Mannit zu etwa 2%, dessen Menge im Sommer herabsinkt, im Herbst wieder aufsteigt und im Dezember ca. 2% erreicht. Die Laubblätter von *Osmanthus aquifolius* und *Ligustrum japonicum* verlieren den Mannit im Sommer vollständig wie *Gardenia*. (Vergl. Tab. XI.)

In den Laubblättern von einigen immergrünen Oleaceen finden wir also im grossen und ganzen einen ähnlichen Gang der Mannitschwankung wie in denen von *Gardenia jasminoides*.

## (3) Mannitschwankung im Laubblatt eines laubabwerfenden Baumes

Ein laubabwerfender Mannitbaum, *Punica Granatum*, wurde zur Untersuchung herangezogen. Bei dieser Pflanze ist zunächst keine merkliche Veränderung vom Mannitgehalt der Laubblätter im Laufe eines Tages festzustellen. Der Laubspross schiesst am Ende April hervor. Der Mannit entsteht in jungen Blättern Anfang Mai schon zu ca. 2%, danach sinkt seine Menge am Ende des Sommers bis zu 1%

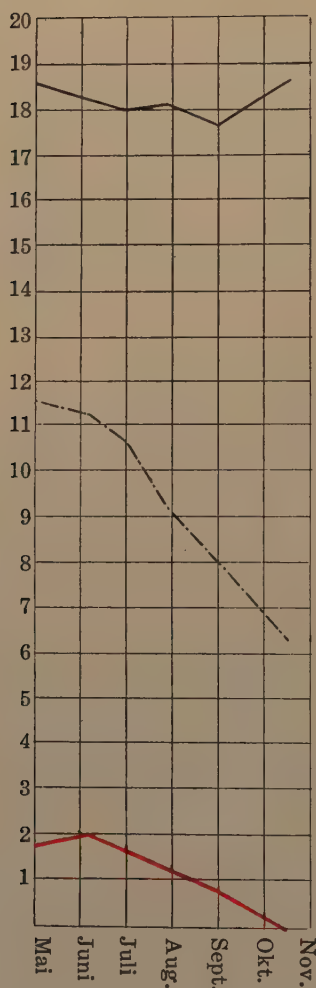


Fig. 3. — Schwankung der Zucker-, Stärke-, und Mannitmenge in den Laubblättern von *Punica Granatum*. Ordinaten sind die Menge der Substanzen in g für 100 g Blatttrockengewicht. — reduzier. Substanz — Stärke und — Mannit.

herab, und je weiter es in den Herbst geht, desto geringer wird der Mannit an Menge; endlich verschwindet er aus den vergilbten Laubblättern schon vor dem Laubfall. Junge Blätter enthalten im Mai eine reduzierende Substanz in einer so ausgiebiger Menge wie 18,69%. Sie ist noch beim Laubfall in fast derselben Menge beibehalten. Aber der nichtreduzierende Zucker ist dabei stets abwesend. Die Stärke zeigt ihren Maximalgehalt von 11,51% schon im Mai, ihre Menge vermindert sich immer rasch, gleichlaufend wie Mannit, von Juli ab bis zum Laubfall. Hierzu Tab. XII und Fig. 3.

## V. Mannit in einem zweijährigen Kraut

Ich habe neulich den Mannit aus *Veronica Tourneforti* GMELIN, einem zweijährigen Kraut, isoliert. Mitte März enthielten 500 g frischen Materials ca. 10 g Mannit; die Ausbeute betrug, auf Trockensubstanz des Krautes berechnet, etwa 12%. *Veronica Tourneforti* keimt Anfang September in dieser Gegend. Man kann keinen Mannit während des Keimlingsstadium nachweisen, aber Ende Oktober, wo dieses Kraut etwa 10 cm hoch entwickelt ist, finden wir diese Substanz nur spurenweise; ihr Gehalt vermehrt sich im November deutlich. Die Periode der maximalen Anhäufung des Mannits fällt in Ende Januar bis Anfang Februar, und im Mai verschwindet der Mannit aus der Pflanze gänzlich.

TABELLE VI

	Sept.	Okt.	Dez.	Jan.	Feb.	März	Apr.	Mai
Mannitmenge	—	sp.	+	+++	+++	++	+	—

Dieses Resultat stimmt interessanterweise mit dem bei *Gardenia jasminoides* u. a. beobachteten überein, auch dieses Kraut pflegt in der kältesten Jahreszeit den Mannit reichlich aufzuspeichern.

## VI. Jährliche Schwankung der Kohlehydrate im Laubblatt eines Zuckerstrauchs

Die Kohlehydratumwandlung in immergrünen Laubblättern zu verschiedenen Jahreszeiten und ihre mutmassliche physiologisch-ökologische Bedeutung wurden schon von mehreren Forschern studiert. Den ersten Beobachtungen von MER<sup>(1)</sup> und von SCHULZ<sup>(2)</sup> folgend, hat LIDFORSS<sup>(3)</sup> auf mikrochemischem Wege festgestellt, dass in Nordeuropa verschiedene immergrüne Laubblätter während des Winters völlig stärkefrei werden und dafür den reduzierenden Zucker öfters in reichlicher Menge aufspeichern. Erst im Frühjahr tritt eine bedeutende Anhäufung der Stärke ein. Aber selbst in der kältesten Jahreszeit lassen sich die Stärke in Schliesszellen regenerieren, wenn man die Blätter in Wärme bringt. Die Kohlehydratumwandlung im Winter soll für die Pflanzen den Kälteschutz bedeuten. Nach BADALLA<sup>(4)</sup> geht aber in Ober-Italien die Stärkeentleerung im Winter bei immergrünen Gewächsen nicht vollständig vor sich. Eine mikrochemische Untersuchung von K. MIYAKE<sup>(5)</sup> an verschiedenen japanischen immergrünen Pflanzen hat auch ergeben, dass ihre Laubblätter dort die Stärke während des Winters in bedeutender Menge verlieren, doch nur in seltenen Fällen vollständig.

(1) E. MER, Bull. Soc. Bot., **23**, 1876, 231.

(2) E. SCHULZ, Flora, **233**, 1888, 248.

(3) B. LIDFORSS, Botan. Centralbl., **68**, 1896, 33; Lunds Univ. Arskrift, N. F., **2**, Afd. 2, 1907, Nr. 13.

(4) L. BADALLA, Ann. di Bot., **8**, 1910, 549.

(5) K. MIYAKE, Bot. Mag., Tokyo, **14**, 1900, Nr. 158; Bot. Gaz., **33**, 1902, 321.

In neuerer Zeit hat F. A. PREISING<sup>(1)</sup> die Kohlehydratumwandlung von zwei europäischen Immergrünen, *Ilex Aquifolium* und *Hedera Helix*, im Laufe eines Jahres quantitativ-analytisch studiert. Im winterlichen Zustand fehlt den Laubblättern die Stärke vollständig, aber merkwürdigerweise kommen darin auch die Zuckerarten nur in minimalen Mengen vor. Was für ein Stoff an deren Stelle auftritt, ist vorläufig nicht bekannt.

Die sich im April entfaltenden Laubblätter von *Daphne odora* enthalten den reduzierenden Zucker in der Menge von 14,11 %, was den Höchstwert in der ganzen Blattlebensdauer darstellt. Der reduzierende Zucker, dessen Menge ja sehr von Assimilationsbedingungen abhängig sein kann, ist das ganze Jahr hindurch nachweisbar, und zwar reichlicher im Sommer als im Winter. Demgegenüber ist eine bedeutende Schwankung der Menge des nichtreduzierenden Zuckers sehr beachtenswert. Nichtreduzierender Zucker ist zuerst im April zu 5,89 % enthalten, geht im Sommer ein wenig an Menge herab, aber schon im Oktober nimmt er plötzlich zu, im Februar erreicht das Jahresmaximum von 15,11 % und fällt dann bis zum nächsten Mai steil herab. Stärke nimmt von dem Gehalt von 8,60 % im Mai monatlich sehr allmählich ab, kommt im Januar zu dem Jahresminimum von 5,66 % an und steigt bis zum nächsten Mai wieder an. (Siehe Tab. XIII u. Fig. 4.)

Der Verlauf der jährlichen Schwankung des nichtreduzierenden Zuckers in den immergrünen Laubblättern von *Daphne odora* bietet uns einen interessanten Vergleich mit dem Verhalten des Mannits bei *Gardenia* dar. Bei *Gardenia* kommt zwar der nichtreduzierende Zucker nur in geringer Menge und bleibt das ganze Jahr hindurch ohne deutliche Schwankung; dagegen erfährt die Mannitmenge eine grosse Zunahme in der kältesten Jahreszeit.<sup>(2)</sup>

Die winterliche Anhäufung von beiden löslichen Produkten, Mannit und Zucker, in den Laubblättern von *Gardenia* bzw. *Daphne* soll auf einen gemeinsamen physiologischen Vorgang hindeuten, worüber wir unten nochmals zur Besprechung kommen werden.

---

(1) F. A. PREISING, Botan. Archiv, **30**, 1930, 241. (Der Autor hat für seine Zuckerbestimmung die WILLSTÄTTER-SCHUDELSche Methode benutzt, die bekanntlich nur Aldosen erfasst.)

(2) Der Verfasser hat früher gezeigt, dass das Glykosid Daphnin in Laubblättern von *Daphne odora* ein deutliches winterliches Minimum in seinem Gehalt aufweist. (Acta Phytchim., **5**, 1930, 16).



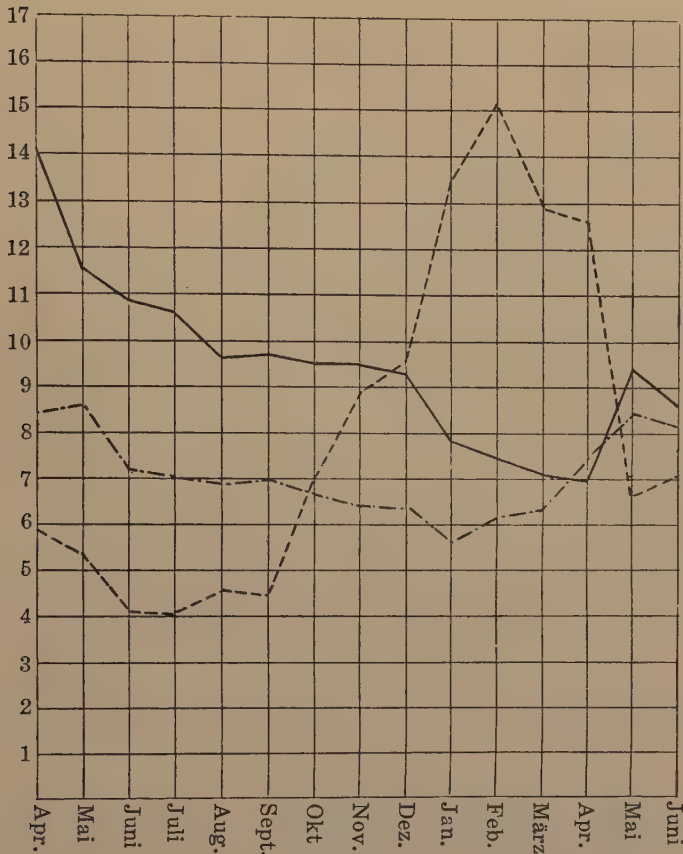


Fig. 4a.—Schwankung der Kohlehydrate in den Laubblättern von *Daphne odora*. Die Ordinaten geben die Kohlehydratmenge in g für 100 g getrockneten Blattsubstanz. — reduzier. Zucker, ..... nichtreduzier. Zucker und -.-.- Stärke.

## VII. Umwandlung des Mannits in den Achsenorganen

Es ist eine wohl bekannte Tatsache, dass verschiedene parenchymatische Gewebe der Achsenorganen wie Rinden-, Holzparenchym, Markstrahlen u. s. w. die Rolle des Kohlehydratspeichers spielen und ihr Stoff-Gehalt sich je nach den Jahreszeiten in beträchtlicher Weise ändert. Der Mannit wurde bei höheren Pflanzen zuerst in den Rindenteilen aufgefunden, und auch die höchste Ausbeute an diesem

Stoff ist gewöhnlich dort zu erzielen. Dass aber der Mannit nicht auch den Holzgeweben fehlt, konnte ich vielfach konstatieren.

HARTIG<sup>(1)</sup> wusste schon früher davon, dass Stärke in den Baumstämmen in gewisser Vegetationsperiode ausgiebig vorkommt, und nachdem schon die winterliche Umwandlung von Stärke in Fett in gewissen Bäumen bekannt wurde, hat zuerst LECLERC DU SABLON<sup>(2)</sup> eingehende quantitative Untersuchungen über die Schwankung des Zucker- und Stärke-Gehaltes angestellt. Nach ihm liegt an Stammorganen der laubabwerfenden Bäume das Zuckermaximum überhaupt im Februar und das Stärkemaximum im Herbst; aber bei den immergrünen Gewächsen ist die Jahreszeit für das Stärkemaximum verschiedenartig, bald im Mai, bald schon im März.

Nach der Erfahrung über die Mannitschwankung in den Laubblättern bin ich hierbei auf den Gedanke gekommen, die Untersuchung im Januar, April, Juni und Oktober vorzunehmen, wo die ergiebige jahresperiodische Stoffumwandlung am ehesten zu erwarten ist.

Das Versuchsmaterial wurde aus den Zweigen und Wurzeln von etwa 1-2 cm Dicke gewonnen. Der Rindenteil wurde zuerst mittels stumpfen Messers vom oberflächlichen Kork befreit, das darunter liegende grüne Phelloderm und der innere weisse Bast wurden gesondert präpariert. Die Wurzelrinde wurde auch in gleicher Weise behandelt. Der Holzteil wurde stets zu dünnen Spänen gebracht.

#### (1) Schwankung des Mannitgehaltes des Zweiges und der Wurzel bei *Gardenia jasminoides*

Bei *Gardenia jasminoides* stimmen der Gehalt und das winterliche Auftreten des Mannits in Phelloderm und Bast des Zweiges mit denjenigen in Laubblättern beinah überein. Nur ist die beobachtete Maximalgehalt in Rindenteilen ein wenig (1-2 %) niedriger als in Laubblättern. Die Kurven bei Phelloderm und Bast unterscheiden sich kaum von einander. (Siehe Tab. XIV, 1, 2; Fig. 4 u. 5.) Im Holzteil beträgt die Maximal-Ausbeute des Mannits am Ende Januar ca. 3 % des Trockengewichtes, also nur halb so gross wie im Bastteil, folglich nimmt die Kurve der Zu- und Abnahme vom Mannit im Holzteil einen etwas flachen Verlauf (Tab. XIV, 3; Fig. 6). Es ist ferner beachtenswert, dass die Schwankung des Mannitgehaltes

(1) TH. HARTIG, Journ. parkt. Chem., **5**, 1835, 217.

(2) LECLERC DU SABLON, Compt. rend., **135**, 1902, 866; **140**, 1905, 1608; Rev. gén. Bot., **18**, 1906, Nr. 205.

in der Wurzelrinde wesentlich der im Holzteil gleicht und die maximale Menge des Mannits in der ersteren auch kaum 3% übersteigt (Tab. XIV, 4; Fig. 7).

Aus obigem ersieht man, dass das jahresperiodische Auftreten des Mannits bei *Gardenia jasminoides* in allen Pflanzenteilen in ganz übereinstimmender Weise erfolgt, aber seine winterliche Anhäufung im inneren Holzteil oder in Wurzeln viel geringer ist als in oberirdischen, der Kälte ausgesetzten Teilen, d.h. Laubblättern und Rinden.

*Gardenia jasminoides* ist ein stärkeaufspeichernder Strauch. Die Stärkemenge in Zweig- und Wurzelgeweben zeigt eine auffallende Jahresperiode, ihr Jahresmaximum liegt im Juli und -minimum fällt in die Winterzeit. Die Kurve des Stärkegehaltes nimmt immer der des Mannits entgegengesetzten Verlauf. Reduzierender und nicht-reduzierender Zucker zeigten im allgemeinen nur eine geringe Schwankung zu verschiedenen Jahreszeiten. Jedoch kommt dem nichtreduzierenden Zucker im Zweigbast eine deutliche winterliche Zunahme zu; sein grösster Gehalt im Januar beträgt 5 %, also etwas weniger als Mannit. (Vergl. Tab. XIV; Fig. 4, 5 u. 6.)

## (2) Mannit und Kohlehydrate in den Achsenorganen von einigen Oleaceen

Der Rindenteil von einigen zu den Oleaceen gehörenden immergrünen Bäumen enthält den Mannit etwas mehr im Winter als im Sommer, aber er kommt nie im Sommer zum gänzlichen Verschwinden wie bei *Gardenia*. *Jasminum odoratissimum* zeigt im Sommer ungefähr 2% und *Osmanthus fragrans* ca. 1% Mannitgehalt (Tab. XV u. XVI).

Im Holzteil tritt der Mannit in beiden Fällen nur in geringer Menge, deren Unterschied zwischen Sommer und Winter ist auch nicht vorhanden.

*Jasminum odoratissimum* ist ein zuckerreicher Baum und enthält den nichtreduzierenden Zucker in allen Pflanzenteilen weit mehr als den reduzierenden Zucker, and zwar in der Zweig- und Wurzelrinde 5-6 mal mehr im Winter, 3-4 mal mehr im Sommer. In den Rinden tritt reduzierender Zucker etwas reichlicher im Sommer als im Winter auf, und nichtreduzierender Zucker kommt in der kältesten Jahreszeit zu ca. 15,3% gegen 9% im Sommer vor. Stärke in Rinden zeigt einen grösseren Gehalt im Sommer als im Winter. Im allgemeinen sind die

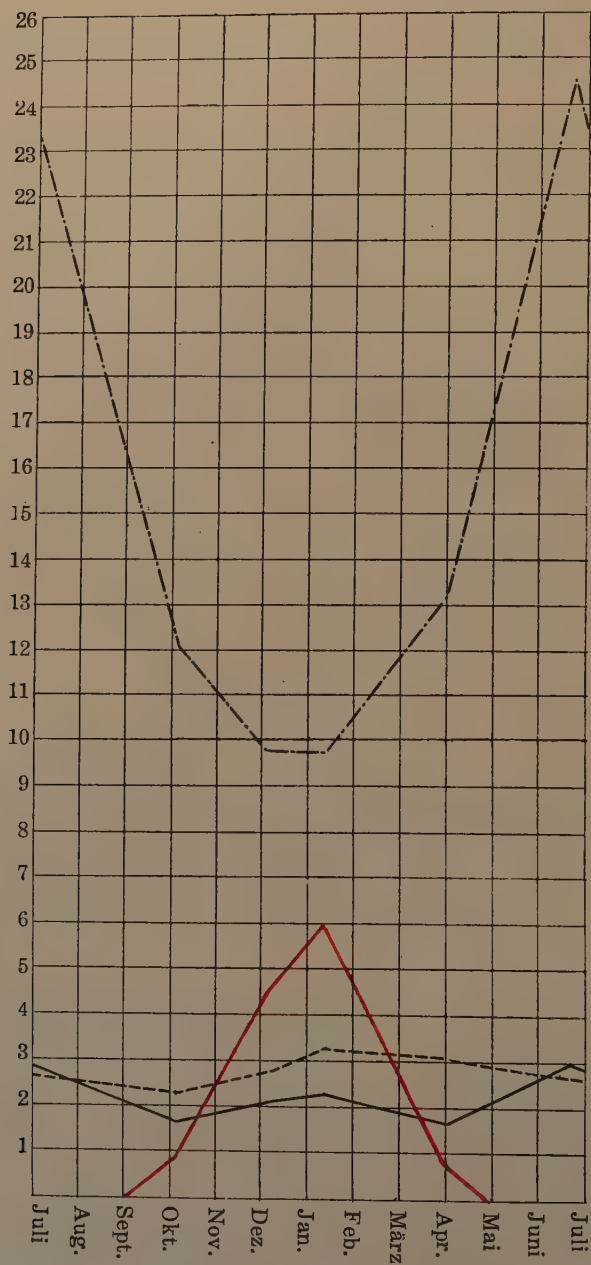


Fig. 4b. — Die Kurven zeigen die Veränderung der Zucker-, Stärke- und Mannitmenge im Phelloderm von *Gardenia jasminoides* in verschiedenen Jahreszeiten. Ordinaten sind die Menge der Substanzen in g für 100 g Trockensubstanz.  
 — reduzier. Zucker, ..... nichtreduzier. Zucker,  
 -.-.- Stärke und — Mannit



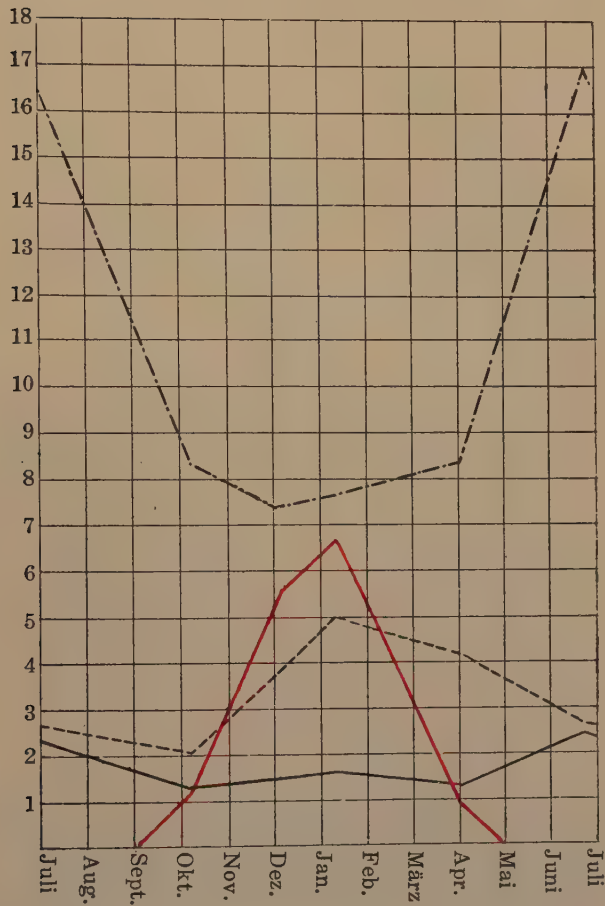


Fig. 5.—Die Kurven zeigen die Veränderung der Zucker-, Stärke- und Mannitmenge im Bast von *Gardenia jasminoides* in verschiedenen Jahreszeiten. Ordinaten geben die Menge der Substanzen in g für 100 g Trockensubstanz.  
 — reduzier. Zucker, --- nichtreduzier. Zucker, — · — Stärke und — Mannit

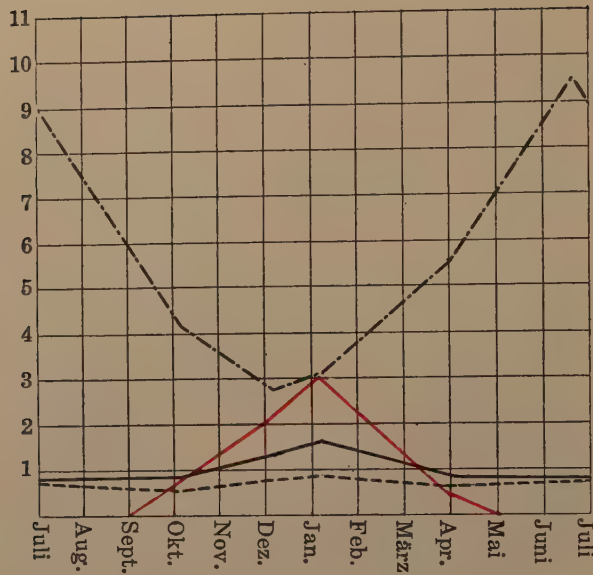


Fig. 6.—Die Kurven zeigen die Veränderung der Zucker-, Stärke- und Mannitmenge im Holz von *Gardenia jasminoides* in verschiedenen Jahreszeiten. Die Ordinaten geben die Menge der Substanzen in g für 100 g Trockensubstanz. — reduzier. Zucker, ..... nichtreduzier. Zucker, ——— Stärke und — Mannit.

Kohlehydrate im Holz immer weit weniger als in Rinden vorhanden, doch weist nichtreduzierender Zucker hier auch einen deutlichen Mehrgehalt im Winter auf.

*Osmanthus fragrans* zeigt in verschiedenen Pflanzenteilen keinen so auffallenden Unterschied zwischen sommerlichem und winterlichem Kohlehydratgehalt. (Tab. XVI.)

### (3) Jahresperiodische Veränderung der Mannit-, Zucker- und Stärkemenge in den Achsenorganen von *Punica Granatum*

Der Rindenteil von *Punica Granatum* behält etwa 1,5% Mannitgehalt vom Mai bis Anfang September, der Gehalt fängt sich kurz vor dem Laubfall allmählich zu vermehren an, erreicht in der kältesten Jahreszeit das Maximum von etwa 3,5%, und danach fällt er fort-

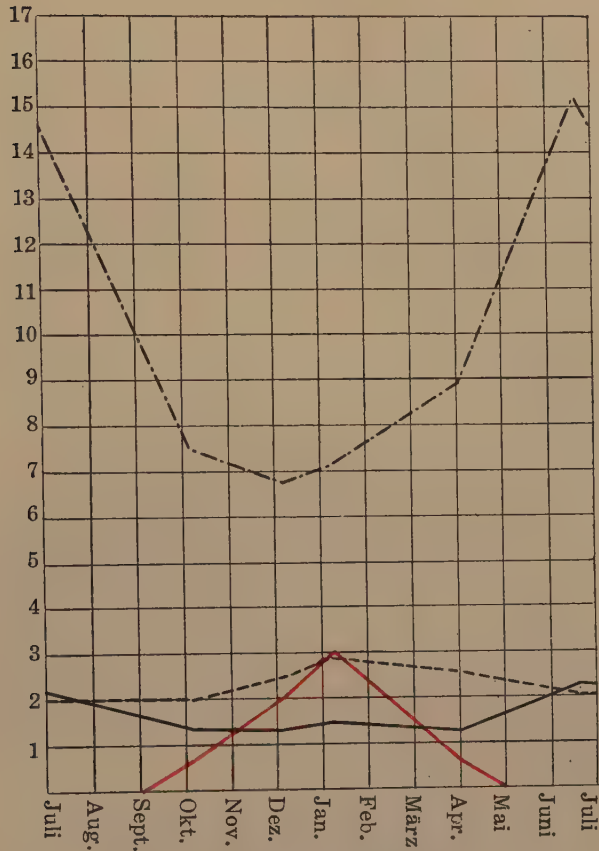


Fig. 7.—Die Kurven zeigen die Veränderung der Zucker-, Stärke- und Mannitmenge in der Wurzelrinde von *Gardenia jasminoides* in verschiedenen Jahreszeiten. Die Ordinaten geben die Menge der Substanzen in g für 100 g Trockensubstanz. — reduzier. Zucker, ..... nichtreduzier. Zucker, — — — Stärke und Mannit.

während bis zum niedrigen Wert im Sommer herab. Der Holzteil enthält ebenfalls im Winter eine bedeutende Menge. Der Verlauf der Mannitkurve im Holz ist ganz ähnlich dem im Rindenteil, auch hierbei kommt der Mannit den ganzen Sommer hindurch in einem Gehalt von 1% vor. (Tab. XVII, 1, 2; Fig. 8 u. 9.) In der Wurzelrinde ist der Mannit zu etwa 3% in jeder Jahreszeit vorhanden (Tab. XVIII).

In der Rinde zeigt die reduzierende Substanz im September das Jahresminimum von 17,02% und die Kurve steigt dann sehr steil zum Maximum von 29,02% im Februar an, danach fällt sie rasch bis zum nächsten Mai ab. Die reduzierende Substanz, die als Zucker berechnet, in ungewöhnlich grosser Menge vorkommt, bleibt in ihrer chemischen Natur noch näher festgestellt zu werden. Diese reduzierende Substanz ist auch im Holz vorhanden, aber in viel geringerer Menge, und zwar mit winterlichem Maximum von 4,5%. Der nichtreduzierende Zucker ist hierbei, wie auch bei den Laubblättern, gar nicht oder spurenweise nachzuweisen.

Stärke im Rindenteil fängt von Mai sich zu vermehren an, erreicht ihr Maximum von 15,16% im Oktober und nimmt danach schnell zum minimalen Gehalt von etwa 5% im Januar und Februar ab, um wieder vom März ihre Menge zu vergrössern (Tab. XVII, 1; Fig. 8).

Im Holzteil wird Stärke schon im August zu 11,67% aufgespeichert und kommt zu ihrem Maximalgehalt (12,41%) im Oktober; das Jahresminimum (etwa 3,5%) fällt in Januar-Februar (Tab. XVII, 2; Fig. 9). Man bemerkt mit aller Deutlichkeit, dass die Stärke-Kurve stets einen der des Mannits und der reduzierenden Substanz ganz entgegengesetzten Verlauf nimmt.

Die Wurzelrinde enthält auch die reduzierende Substanz in grosser Menge (31,73%) im Februar, selbst im Sommer geht er nicht unter 23%. Aber nichtreduzierender Zucker wird dabei nur im Sommer spurenweise gefunden. (Tab. XVIII.)

### VIII. Mannit in Blüten und Schoten von *Gardenia jasminoides*

Es war bisher wenig beachtet, dass in den Blütenblättern der Zuckeralkohol oft in nicht unbedeutender Menge enthalten ist. Wir haben den Mannit zuerst in den Blüten von *Gardenia jasminoides*<sup>(1)</sup>, danach auch in denen von einigen Oleaceen-Arten, *Punica Granatum* und *Veronica Tourneforti* festgestellt. Der Mannitgehalt der Blüten (Kronenblätter) beträgt bei *Gardenia* sogar 3,86% der Trockensubstanz. (Tab. XIX.)

Bei *Gardenia* ist der Mannit in den reifen Schoten (im Dezember) ein wenig vorhanden, aber er kommt in der Fruchthülle von *Punica Granatum* gar nicht vor.<sup>(2)</sup>

(1) T. ASAI u. M. NAKAMURA, Bot. Mag., Tokyo, 33, 1919, 71.

(2) Ich habe ferner aus den Blüten von *Celastrus articulatus*, *Evonymus europaea* var. *Hamiltoniana* und *Evonymus japonica*, Dulcit (Schmp. 188°) isoliert.



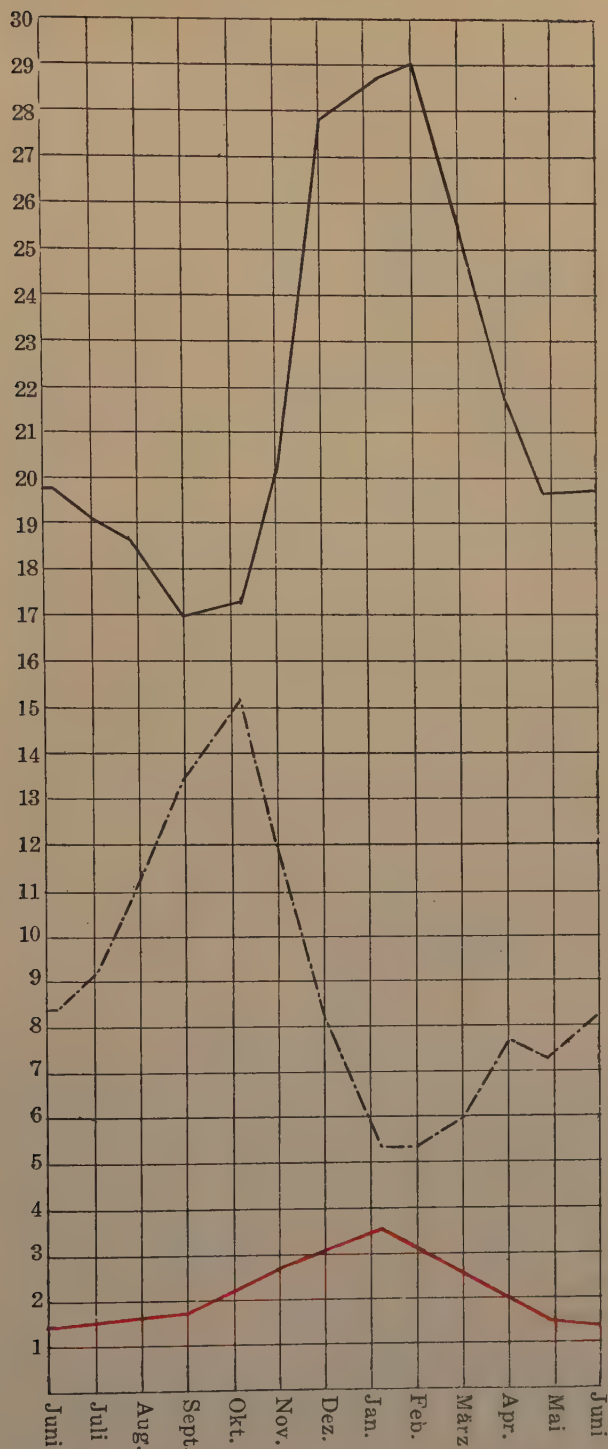


Fig. 8.—Die Schwankung der Mannit-, Zucker- und Stärke-Menge in der Rinde von *Punica Granatum* in verschiedenen Jahreszeiten. Die Ordinaten geben die Menge der Substanzen in g für 100 g Trockensubstanz. — Reduzier. Substanz, — — — Stärke und — Mannit

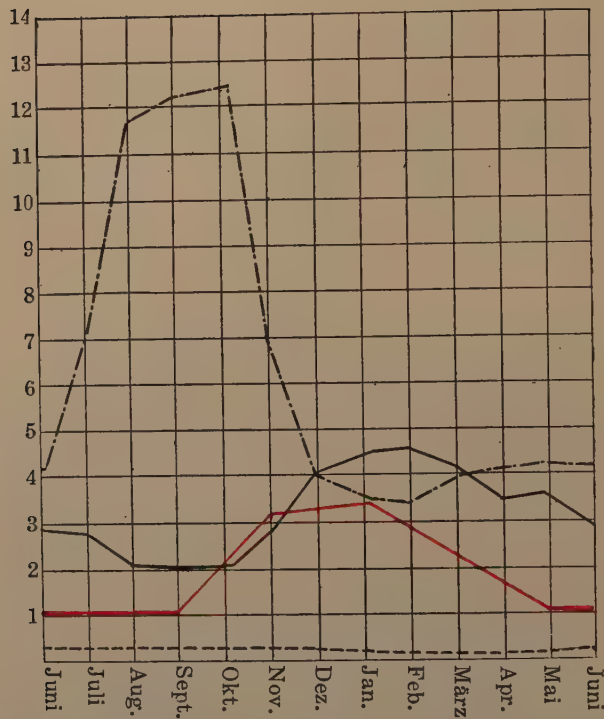


Fig. 9.—Die Schwankung der Mannit-, Zucker- und Stärke-Menge im Holz von *Punica Granatum* zu verschiedenen Jahreszeiten. Ordinaten sind die Menge der Substanzen in g für 100 g Trockensubstanz. — reduzier. Substanz, ..... nichtreduzier. Zucker, — · — · — Stärke und — Mannit.

## IX. Zusammenfassung

1. Die untersuchten höheren Mannitpflanzen enthalten den Mannit in sämtlichen Vegetationsorganen und zwar immer reichlicher in Laubblättern und Stammrinden als in Wurzeln und Holzgeweben.

2. Die Mannitbildung in verschiedenen Pflanzen zeigt keinen nachweisbaren Zusammenhang mit den Assimilationsbedingungen, sodass der Mannit kaum als ein Produkt der Photosynthese in Betracht kommt. Viel auffallender ist aber die klimatisch bedingte, periodische Schwankung des Mannitgehaltes von Laubblättern und anderen Organen im Laufe eines Jahres.

3. Bei *Gardenia jasminoides* fehlt der Mannit den Laubblättern während des Sommers vollständig, tritt darin erst im Oktober auf, seine Menge vermehrt sich rasch zum Winter und erreicht das Jahres-

maximum (ca. 8 % der Trockensubstanz) im Februar, dann nimmt er schnell an Menge ab, um schon im Mai gänzlich zu verschwinden. Die jährliche Periodizität des Mannitgehaltes in Stämmen und Wurzeln verläuft in ähnlicher Weise wie in Laubblättern. Aber die Mannitmenge in Holzgeweben und Wurzelrinden ist stets weniger als in Laubblättern und Stammrinden und schwankt jahreszeitlich auch in kleinerem Umfang.

4. Bei einigen zu den Oleaceen gehörenden, immergrünen Mannitbäumen wird der Mannit in Laubblättern nicht völlig entleert, sondern kommt dort ganzen Sommers vor, obzwar in viel geringerer Menge als im Winter.

5. Bei einem laubabwerfenden Mannitbaum, *Punica Granatum* vermindert der Mannit in den Laubblättern sich vom Frühling bis zum Herbst immerfort und verschwindet vor dem Laubfall gänzlich. Aber die Mannitmenge in Rinden- und Holzteilen fängt von Anfang Herbst sich zu vergrößern an und erreicht ihr Maximum von ca. 3,5 % in der kältesten Jahreszeit; im Sommer beträgt sein Gehalt 1–1,5 %. Die Wurzelrinde zeigt keine deutliche Veränderung des Mannitgehaltes im Laufe eines Jahres.

6. Ein zweijähriges Kraut, *Veronica Tourneforti*, weist einen ansehnlichen Mannitgehalt (zu ca. 12 % der Trockensubstanz) auf. Bei der im Oktober auskeimenden Pflanze finden wir den Mannit nur spurenweise, sein Gehalt zeigt eine auffallende Vergrößerung im Januar-Februar und verschwindet wieder im Mai bevor das Kraut verdorrt.

7. Die Blütenblätter von verschiedenen Mannitpflanzen enthalten diese Substanz oft in bedeutender Menge.

8. Der Stärkegehalt der Laubblätter und der anderen Vegetationsorgane macht in untersuchten Mannitpflanzen eine Jahresperiode durch, die immer der des Mannits entgegengesetzt verläuft, d. h., das Jahresmaximum liegt im Sommer und -minimum im Winter.

9. Der nichtreduzierende Zucker zeigt öfters eine jahreszeitliche Schwankung des Gehaltes, die gleichsinnig wie Mannit vor sich geht. Auch in den Laubblättern von einem mannitfreien Strauch, *Daphne odora*, wurde eine bedeutende Zunahme des nichtreduzierenden Zuckers im Winter an Stelle der sich vermindernden Stärke festgestellt.

---

Die experimentelle Bearbeitung und die theoretische Auseinandersetzung des Gegenstandes beabsichtige ich im II. Teil vorliegender Arbeit hervorzuheben, welcher demnächst in dieser Zeitschrift erscheinen wird.

---

## X. Zusammenstellung der Tabellen

TABELLE VII

Mannitgehalt der Laubblätter von *Gardenia jasminoides*, gesammelt alle drei Stunden.

## (1) Wildwachsender Stock

16. Dez.		Sonnenaufgang Sonnenuntergang	7h 12 <sup>m</sup> vorm. 5h 13 <sup>m</sup> nachm.	
Sammelzeit	Temp.	Trockensubst. in Proz.	Mannit pro 100 g Frischgew. in g	Mannit pro 100 g Trockengew. in g
6h v.	4°C.	40,55	2,25	5,55
9h v.	6°C.	40,74	1,97	4,84
Mittag	11,5°C.	41,05	2,01	4,90
3h n.	12,5°C.	41,09	2,23	5,43
6h n.	7,5°C.	40,71	2,27	5,58
9h n.	6°C.	40,52	2,27	5,60

## (2) Kultivierter Stock

10. Dez.		Sonnenaufgang Sonnenuntergang	7 <sup>h</sup> 7 <sup>m</sup> vorm. 5 <sup>h</sup> 12 <sup>m</sup> nachm.	
Sammelzeit	Temp.	Trockensubst. in Proz.	Mannit pro 100 g Frischgew. in g	Mannit pro 100 g Trockengew. in g
6 <sup>h</sup> v.	4,5°C.	39,55	2,10	5,31
9 <sup>h</sup> v.	6°C.	40,10	2,20	5,49
Mittag	12°C.	41,15	2,06	5,01
3 <sup>h</sup> n.	12,5°C.	41,55	2,07	4,98
6 <sup>h</sup> n.	8°C.	41,35	2,00	4,84
9 <sup>h</sup> n.	6°C.	39,75	2,03	5,11



## TABELLE VIII

Zucker- und Stärkegehalt der Laubblätter einiger Pflanzen, gesammelt alle drei Stunden.

(1) *Brassica campestris*  
var. *rapifera*

19. Dez.                      Sonnenaufgang                      7h 14m vorm.  
                                    Sonnenuntergang                      5h 14m nachm.

Sammelzeit	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht		
			Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
6h v.	−1° C.	14,10	6,13	5,15	3,37
9h v.	1° C.	14,30	6,67	5,42	3,37
Mittag	8° C.	14,36	7,64	5,54	3,39
3h n.	9,5° C.	14,41	8,58	5,53	3,38
6h n.	7° C.	14,25	9,15	5,69	3,39
9h n.	5° C.	14,00	8,48	5,43	3,39

(2) *Citrus Aurantium* L.  
subsp. *nobilis* MAK.

19. Dez.                      Sonnenaufgang                      7h 14m vorm.  
                                    Sonnenuntergang                      5h 14m nachm.

Sammelzeit	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht		
			Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
6h v.	−1° C.	40,53	4,63	4,27	4,59
9h v.	1° C.	40,46	4,65	4,26	4,59
Mittag	8° C.	42,78	4,69	4,59	4,58
3h n.	9,5° C.	43,48	4,69	4,98	4,59
6h n.	7° C.	40,47	4,69	4,77	4,59
9h n.	5° C.	40,43	4,64	4,66	4,59

TABELLE VIII (Fortsetzung)

(3) *Gardenia jasminoides*

10. Dez.                      Sonnenaufgang                      7h 8m vorm.  
                                     Sonnenuntergang                      5h 12m nachm.

Sammelzeit	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht		
			Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
6h v.	4,5° C.	39,55	6,44	3,10	8,95
9h v.	6° C.	40,10	6,48	3,08	8,95
Mittag	12° C.	41,15	6,52	3,24	9,07
3h n.	12,5° C.	41,55	6,72	3,22	9,05
6h n.	8° C.	41,35	6,55	3,13	9,07
9h n.	6° C.	39,75	6,52	3,04	9,05

(4) *Aspidistra elatior*

19. Dez.                      Sonnenaufgang                      7h 14m vorm.  
                                     Sonnenuntergang                      5h 14m nachm.

Sammelzeit	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht		
			Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
6h v.	-1° C.	33,51	2,84	12,32	2,89
9h v.	1° C.	33,25	2,81	12,09	2,89
Mittag	8° C.	34,52	3,30	12,62	2,88
3h n.	9°,5 C.	34,96	3,41	13,41	2,90
6h n.	7° C.	34,51	3,29	12,67	2,90
9h n.	5° C.	34,64	2,88	12,63	2,90

TABELLE IX

Monatliche Schwankung der Mannit-, Zucker- und Stärkemenge in den Laubblättern von *Gardenia jasminoides*

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
21. Juni	24°C.	29,01	0	4,17	2,88	14,49
15. Juli	29°C.	33,68	0	4,04	2,81	13,62
15. Aug.	32°C.	34,79	0	3,40	2,20	11,08
16. Sept.	27,5°C.	36,81	0	3,54	2,51	11,16
15. Okt.	20°C.	33,27	1,02	3,82	2,07	10,66
15. Nov.	19°C.	40,51	3,43	4,28	2,22	9,14
15. Dez.	13°C.	42,50	5,53	4,35	2,50	9,24
16. Jan.	10°C.	42,47	7,09	4,73	2,74	9,13
16. Feb.	9°C.	42,85	8,05	4,64	2,67	10,02
16. März	14°C.	43,60	3,62	3,91	2,58	10,66
15. Apr.	17°C.	43,77	0,80	3,69	2,85	16,37
14. Mai	21°C.	43,62	0	3,55	3,10	19,32
13. Juni	25°C.	42,18	0	3,48	3,20	14,55
15. Juli	29°C.	42,16	0	3,73	2,62	12,51
15. Aug.	32°C.	40,76	0	3,69	2,58	12,32
16. Sept.	27°C.	40,59	0	4,07	2,83	12,81
15. Okt.	20°C.	40,45	0	3,78	1,46	10,92

TABELLE X

Mannit- und Kohlehydratgehalt der Laubblätter einiger *Gardenia*-Arten

(1) Im Winter

Pflanze	Datum	Temp.	Trocken- subst. in Proz.	pro 100 g Trockengewicht				Blatt- zahl pro 100g Frisch gew.
				Mannit in g	Re- duzier. Zucker in g	Nichtre- duzier. Zucker in g	Stärke in g	
<i>Gardenia jasminoides</i> (wildwachsend im Schatten)	15. Jan.	9°C.	41,48	6,94	4,33	2,64	9,04	213
<i>Gardenia jasminoides</i> (Kultur im Licht)	15. Jan.	9°C.	41,39	7,13	6,43	3,16	9,22	462
<i>Gardenia florida</i> var. <i>flore pleno</i>	6. Jan.	9°C.	46,52	9,44	4,27	5,92	7,56	128
<i>Gardenia radicans</i>	7. Jan.	8°C.	45,86	6,83	6,27	3,77	9,45	2064

TABELLE X (Fortsetzung)

(2) Im Sommer

Pflanze	Datum	Temp.	Trocken- subst. in Proz.	pro 100 g Trockengewicht				Blatt- zahl pro 100g Frisch- gew.
				Mannit in g	Re- duzier. Zucker in g	Nichtre- duzier. Zucker in g	Stärke in g	
<i>Gardenia jasminoides</i> (wildwachsend im Schatten)	31. Juli	31°C.	39,86	0,00	3,91	2,39	12,12	192
<i>Gardenia jasminoides</i> (Kultur im Licht)	31. Juli	31°C.	39,41	—	5,24	2,57	13,16	438
<i>Gardenia florida</i> var. <i>flore pleno</i>	14. Juli	31°C.	38,48	—	3,75	4,45	9,62	110
<i>Gardenia radicans</i>	14. Juli	31°C.	38,83	—	4,72	2,67	11,17	1940

TABELLE XI

Mannitgehalt der Laubblätter einiger Arten von Oleaceae

Pflanze	Datum Blattalter	Temp.	Trockensubst. in Proz.	Mannit pro 100g Trockengew. in g
<i>Jasminum odoratis- simum</i>	16. Mai, jung	24°C.	25,14	0,34
	13. Juni, erwachsen	26°C.	35,48	1,16
	19. Dez., alt	9°C.	36,34	1,60
<i>Osmanthus fragrans</i>	16. Apr., jung	18°C.	30,04	2,22
	7. Juni, erwachsen	27°C.	50,24	0,49
	3. Dez., alt	10°C.	51,06	1,86
<i>Osmanthus aquifolius</i>	18. März, erwachsen	16°C.	44,20	1,65
	4. Aug., „	32°C.	43,99	0
<i>Ligustrum japonicum</i>	26. Juli, erwachsen	32,5°C.	36,82	0
	12. Dez., alt	15°C.	40,87	1,03



TABELLE XII

Jährliche Schwankung der Mannit-, Zucker- und Stärkemenge in den Blättern von *Punica Granatum*.

Datum	Temp.	Blattalter	Trocken- subst. in Proz.	pro 100 g Trockengewicht			
				Mannit in g	Reduzier. Zucker in g	Nichtredu- zier. Zucker in g	Stärke in g
9. Mai	22°C.	Jung	35,64	1,80	18,69	0	11,51
19. Juni	29°C.	Erwachsen	43,40	2,05	18,20	0	11,32
15. Juli	30°C.	„	46,45	—	18,02	0	10,62
12. Aug.	32°C.	„	48,28	—	18,09	0	9,26
16. Sept.	24°C.	„	48,26	0,87	17,67	0	8,01
28. Okt.	19°C.	Vergilbt	54,12	0	18,64	0	6,37

TABELLE XIII

Monatliche Schwankung der Zucker- und Stärkemenge in Laubblättern von *Daphne odora*

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht		
			Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
15. Apr.	17°C.	22,68	14,11	5,89	8,42
16. Mai	20°C.	23,14	11,62	5,38	8,60
16. Juni	24°C.	24,32	10,84	4,07	7,22
15. Juli	28°C.	24,38	10,57	4,13	7,04
15. Aug.	31°C.	24,97	9,66	4,63	6,87
16. Sept.	26°C.	25,61	9,73	4,50	6,99
15. Okt.	21°C.	25,77	9,63	7,04	6,70
16. Nov.	20°C.	26,82	9,55	8,93	6,43
16. Dez.	12°C.	28,70	9,39	9,67	6,37
15. Jan.	9,5°C.	29,91	7,83	13,51	5,66
15. Feb.	8°C.	30,94	7,43	15,11	6,26
17. März	13°C.	31,01	7,14	12,96	6,36
15. Apr.	17°C.	30,44	7,02	12,64	7,48
16. Mai	20°C.	29,34	9,39	6,70	8,38
16. Juni	24°C.	27,86	8,64	7,04	8,22

## TABELLE XIV

Mannit-, Zucker- und Stärkemenge in den Zweig- und Wurzelgeweben von *Gardenia jasminoides* in verschiedenen Jahreszeiten.

## (1) Phelloderm

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
25. Jan.	9°C.	49,28	6,01	2,33	3,38	9,79
16. Apr.	18°C.	48,39	0,79	1,73	3,06	13,25
6. Juli	30°C.	48,62	0	3,01	2,67	24,53
19. Okt.	21°C.	48,45	0,93	1,73	2,35	12,07
21. Dez.	13°C.	49,61	4,50	2,15	2,86	9,82

## (2) Bast

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
25. Jan.	9°C.	50,80	6,73	1,68	5,05	7,69
16. Apr.	18°C.	50,54	0,93	1,35	4,26	8,39
6. Juli	30°C.	49,44	0	2,51	2,73	17,04
19. Okt.	21°C.	49,59	1,19	1,37	2,13	8,36
21. Dez.	13°C.	50,68	5,56	1,57	3,92	7,35

## (3) Holz

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
25. Jan.	9°C.	70,90	3,05	1,71	0,95	3,08
16. Apr.	18°C.	69,52	0,45	0,85	0,61	3,49
6. Juli	30°C.	68,88	0	0,85	0,73	9,40
19. Okt.	21°C.	68,65	0,67	0,87	0,60	4,24
21. Dez.	13°C.	71,02	2,17	1,37	0,81	2,79

TABELLE XIV (Fortsetzung)

## (4) Wurzelrinde

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
25. Jan.	9°C.	55,01	3,05	1,51	2,88	7,13
16. Apr.	18°C.	54,83	0,57	1,28	2,60	7,91
6. Juli	30°C.	54,85	0	2,30	2,05	15,23
19. Okt.	21°C.	54,26	0,68	1,34	1,98	7,50
21. Dez.	13°C.	55,18	2,12	1,30	2,53	6,74

TABELLE XV

Mannit-, Zucker- und Stärkemenge im Zweig und in der Wurzel von  
*Jasminum odoratissimum* im Winter und Sommer

	Datum	Temp.	Trocken- subst. in Proz.	pro 100 g Trockengewicht			
				Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
Rinde	2. Feb.	8°C.	43,22	2,71	2,85	15,32	6,96
	13. Juni	26°C.	39,03	1,84	3,18	9,05	10,66
Holz	2. Feb.	8°C.	65,62	0,44	1,70	4,31	3,07
	13. Juni	26°C.	64,55	0,31	0,92	1,48	3,56
Wurzel- rinde	2. Feb.	8°C.	36,29		2,59	18,46	6,82
	13. Juni	26°C.	29,26		3,47	15,53	8,34

TABELLE XVI

Mannit-, Zucker- und Stärkemenge im Zweig und im der Wurzel von  
*Osmanthus fragrans* in Winter und Sommer

	Datum	Temp.	Trocken- subst. in Proz.	pro 100 g Trockengewicht			
				Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
Rinde	17. Feb.	11°C.	57,77	1,59	2,80	7,71	4,47
	31. Juli	31°C.	47,42	0,91	2,76	5,16	5,76
Holz	17. Feb.	11°C.	61,80	0,57	1,31	2,22	2,49
	31. Juli	31°C.	61,86	0,44	1,09	1,25	2,88
Wurzel- rinde	16. Feb.	9°C.	53,58		2,44	7,60	5,31
	31. Juli	31°C.	50,80		1,97	6,80	5,96

## TABELLE XVII

Jährliche Schwankung der Mannit-, Zucker- und Stärkemenge im Zweige  
von *Punica Granatum*

## (1) Rinde

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
23. Jan.	10°C.	53,63	3,47	28,70	0	5,27
14. Feb.	7,5°C.	53,04		29,02	0	5,29
15. März	15°C.	50,52		25,56	0	5,97
14. Apr.	18°C.	45,93		21,78	0	7,72
9. Mai	22°C.	45,63	1,56	19,68	0	7,28
19. Juni	29°C.	44,73	1,41	19,77	0	8,52
15. Juli	30°C.	44,92	1,65	19,07	0	9,25
12. Aug.	32°C.	44,78		18,67	0	11,13
16. Sept.	24°C.	46,20		17,02	0	13,55
21. Okt.	20°C.	49,04		17,30	0	15,17
14. Nov.	18°C.	49,75	2,65	20,17	0	12,01
16. Dez.	12°C.	51,08	2,65	27,79	0	8,29

## (2) Holz

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
23. Jan.	10°C.	66,88	3,39	4,54	0,22	3,48
14. Feb.	7,5°C.	67,60		4,57	0,20	3,42
15. März.	15°C.	65,90		4,12	0,15	3,93
14. Apr.	18°C.	65,62		3,45	0,17	4,07
9. Mai	22°C.	63,66	1,05	3,63	0,16	4,17
19. Juni	29°C.	63,90	1,00	2,87	0,17	4,15
15. Juli	30°C.	64,62	1,01	2,75	0,30	6,98
12. Aug.	32°C.	64,64		2,15	0,34	11,67
16. Sept.	24°C.	65,62		2,10	0,32	11,18
21. Okt.	20°C.	67,01		2,08	0,35	12,41
14. Nov.	18°C.	66,22	3,11	2,84	0,35	7,02
16. Dez.	12°C.	65,82	3,11	4,12	0,30	3,99



TABELLE XVIII

Mannit-, Zucker- und Stärkemenge in der Wurzelrinde von *Punica Granatum* im Winter und Sommer.

Datum	Temp.	Trockensubst. in Proz.	pro 100 g Trockengewicht			
			Mannit in g	Reduzier. Zucker in g	Nichtreduzier. Zucker in g	Stärke in g
12. Feb.	8°C.	53,52	3,36	31,73	0	6,00
15. Aug.	32°C.	52,56	3,10	23,13	0,34	8,30

TABELLE XIX

Mannitgehalt der Blumenblätter

	Datum	Temp.	Trockensubst. in Proz.	Mannit pro 100 g Frischgew. in g	Mannit pro 100 g Trockengew. in g
<i>Jasminum odoratissimum</i>	16. Mai	24°C.	17,02	0,35	2,06
<i>Ligustrum Ibota</i>	4. Juni	27°C.	31,37	0,35	1,12
<i>Gardenia jasminoides</i>	17. Juni	27°C.	16,57	0,64	3,86

TABELLE XX

Mannitgehalt der reifen und unreifen Schoten von *Gardenia jasminoides*

Datum	Temp.	Trockensubst. in Proz.	Mannit pro 100 g Frischgew. in g	Mannit pro 100 g Trockengew. in g
17. Aug.	31°C.	21,84	0	0
16. Dez.	12,5°C.	41,04	0,23	0,56



# Studies on the species crosses of Japanese *Rhododendron*

## I. On the crossability between various species and the cotyledon color of F<sub>1</sub> seedlings

By Yakichi NOGUCHI

Institute of Plant-Breeding and Genetics, Faculty of  
Agriculture, Tokyo Imperial University

---

With Plates I-II

---

(Received January 28, 1932)

In 1925, Mr. K. SUZUKI, an amateur of plant breeding at Yokohama, informed the author that some of F<sub>1</sub> seedlings from crosses between *Rhododendron obtusum* PLANCH. and *R. japonicum* SURING., which were performed in order to get a yellow-flowered evergreen type, had yellowish white cotyledons and died soon after germination. Similar cases were met with heretofore by DE VRIES (1913)<sup>(1)</sup> and RENNER (1922)<sup>(2)</sup> in *Oenothera* species crosses, by FARENHOLZ (1927)<sup>(3)</sup> in *Hypericum quadrangulum* × *H. acutum* and by MANGELSDORF and EAST (1927)<sup>(4)</sup> in the generic hybrids between *Fragaria vesca* and *Potentilla nepalensis*.

*Rhododendron* is a very polymorphic genus, which contains about 68 Japanese species<sup>(5)</sup>. Moreover, some species have been cultivated in our country since very ancient times, so that we have now more than 400 varieties and some new types have been bred out year by year<sup>(6)</sup>. Their majority might have been produced by spontaneous and artificial hybridization between related species<sup>(7)</sup>.

---

(1) Gruppenweise Artbildung, 1913, 76.

(2) Zeitschr. f. ind. Abst. und Vererb, **27**, 1922, 235.

(3) Festschrift f. Pr. SCHAUINSLAND, Bremen cited by RENNER: Artbastarde bei Pflanzen, 1929, 15.

(4) Genetics, **12**, 1927, 307.

(5) NAKAI, T. and G. KOIDZUMI: Trees and shrubs indigenous in Japan Proper, 1927, 52.

(6) KOMATSU, S.: Bot. Mag. Tokyo, **32**, 1918, 31.

(7) KOMATSU (l. c.) reported that *R. Osakazuki*, KOMAT. may be *R. sublanco-latum*, MIQ. × *R. rosmarinifolium*, DIPPEL; *R. Bungonishiki*, KOMAT. and *R. Sekidera*, KOMAT., *R. indicum*, SWEET. × *R. Kaempferi*, PLANCH.; and *R. tebotan*, KOMAT., *R. Kaempferi*, PLANCH. × *R. rosmarinifolium*, DIPPEL.

NAKAI (l. c.) also indicated in his book that *R. tebotan*, KOMAT. must be the hybrid between *R. transiens*, NAKAI and *R. linearifolium*, MAKINO; and *R. pulchrum*, SWEET that between *R. phoeniceum*, G. DON and *R. mucronatum*, G. DON.

It is easily surmised that the genetical constitution of species in this genus must be very complicated, and we might expect some interesting results in their crosses. From the point of view, both scientific as well as practical, it seems desirable to examine in detail the behavior of species cross in this genus. Some results of the investigation concerning the species crosses of *Rhododendron*, which are now cultivated in Japan, are reported in this paper.

The author wishes to acknowledge his indebtedness to Professor Dr. Masao So, under whose direction the experiments were carried out, for the use of the material as well as his invaluable advice.

### Material and Method

The following species and varieties of *Rhododendron* have been used in these studies. With the exception of a few species grown in the horticultural nursery of the Tokyo Imperial University, they are from the collection of Prof. So in his garden.

#### Sect. Eurhodendron, D. C.

1. *R. Degronianum*, CARRIÈR. 1-6 m. high, branches rather slender; leaves pointed long-ovoid, leathery and more or less glossy, deep green above, pale underneath, deciduous; scapes strong and erect, hairy, many-flowered; flower 5-6 cm. in diameter; gamopetalous, petals pale red; stamens 10, style long and stout; fruits ca 1 cm. in length with brown hairs, seeds very small; self-fertile.

This species grows naturally in mountainous lands in Japan, and is also sometimes cultivated.

#### Sect. Rhodorastrum, MAXIM.

2. *R. mucronulatum*, TURCZ. 2-4 m. high, branches numerous and pretty vigorous. Leaves ovoid, pointed at both ends, hairy above, deciduous; 1-2 flowers contained in one bud, flower 3 cm. in diameter, fully blossoming early spring; petals purple, stamens 10, style glabrous, filaments hairy; fruits ca 1 cm., scaly; rarely self-fertile.

This species is found in cultivation, though rarely.

#### Sect. Sinenses, NAKAI

3. *R. japonicum*, SURING. 1-4 m. high, branches somewhat fine but vigorous. Leaves pointed ovoid with wavy margin, with spreading long hairs above, light green in color, deciduous; many flowers contained in one bud, blossoming before leaves develop, 5-7 cm. in diameter; petals brown red, yellow in a variety (*R. japonicum*, f. *flavum*, NAKAI); stamens 5, both filaments and style glabrous; fruits ca 2-3 cm.; perfectly self-fertile.

This species in Japan Proper is cultivated frequently in the garden. (Pl. I, fig. 1).



## Sect. Verticillatae, NAKAI

4. *R. Schlippenbachii*, MAXIM. 2-4 m. high, rarely 6 m.; branches stout, with spreading fine hairs in the young stage. Leaves very large, round ovoid, deciduous; petioles nearly absent; 2-7 flowers in one bud, flowers 5 cm. in diameter; petals light pink in color; stamens 10, style very long; fruits ca 1-1.5 cm., scarcely self-fertile.

This species is often cultivated in our garden.

## Sect. Tsutsusi, SWEET

1-4 m. high, rarely 5 m.; branches numerous, densely hairy; evergreen with one exception, viz. *R. yedoense*; leaves generally ovoid. Flowers 1-2 in one bud; stamens 5 or 10; almost self-fertile; fruits ca 1 cm. in length, hairy.

Almost all cultivated species of *Rhododendron* in Japan belong to this section.

5. *R. serpyllifolium*, MIQUEL. Only 1 m. high; branches fine; leaves very small, 1.5 cm. Flowers also small, about 1 cm. in diameter; petals light purple; fruits 0.5 cm. in length.

6. *R. obtusum*, PLANCH. Leaves generally small, glossy above, reddish green in some varieties in winter. Flowers 2.5-5 cm. in diameter; stamens 5, style very long; a few varieties self-sterile.

A great many garden-varieties are contained in this species, of which the following have been used in our experiment.

Name of garden-varieties	Flower color
Sakurakirishima ( <i>R. obtusum</i> var. <i>latifolium</i> , NAKAI), (Pl. I, fig. 2)	pink
Benikirishima	red
Toyokirishima	purple
Osakazuki ( <i>R. obtusum</i> var. <i>majus</i> , NAKAI)	red
Miyakoshibori	red-spotted
Azumashibori	fine red-spotted
Tatsutagawashibori	sharply reddish purple-spotted
Hinodetsutsuji	red

7. *R. lateritum*, PLANCH. Branches spreading; leaves hairy above. Flowers 3-6 cm. in diameter, in full bloom at the beginning of summer or midsummer; stamens 5.

This species in Japan Proper and its many varieties, chiefly distinguished by their flower color, were bred in the past. The white-flowered variety has been used in our experiment.

8. *R. Kaempferi*, PLANCH. (f. *Kinshibe*, KOMAT.). Branches long; petals replaced by stamens; stamens 10, red purple, style very long.

9. *R. transiens* var. *acutifolium*, NAKAI. Growth habit almost similar to that of *R. Kaempferi*. Flowers 4 cm. in diameter; petals red-spotted, stamens 10, rarely 7-9.

10. *R. yedoense* var. *poukhanense*, NAKAI. Leaves very thin, somewhat pale green, deciduous; petals purple, stamens 10; fruits round oval.

11. *R. ripense*, MAKINO. Petioles long, ca 1 cm., flowers 4-5 cm. in diameter, petals light purple, stamens 10.

12. *R. mucronatum*, G. DON. Flowers 4-5 cm. in diameter, in bloom at the same time with or before the development of leaves; petals white or red-spotted; stamens 10, style perfectly glabrous. Three garden-varieties—"Shiroriukyu" (flower color white), "Riukyushibori" (flower color reddish purple-spotted) and "Kanokoshibori" (flower color indistinctly reddish purple-spotted)—have been used in our experiment.

13. *R. hortense*, NAKAI. Flowers 6-7 cm. in diameter; petals red purple or red-and-green-spotted; stamens 10. Two garden-varieties—"Murasakiriukyu" (full colored) and "Minenomatsukaze" (spotted)—have been used in our experiment.

14. *R. pulchrum*, SWEET. Growth habit very vigorous; flowers large, 6-7 cm. in diameter; petals purple, stamens 10.

This species is supposed to be a hybrid between *R. sublancoletum*, MIQ. and *R. rosmarinifolium*, DIPPEL. (by KOMATSU)<sup>(1)</sup> or between *R. phoeniceum*, G. DON and *R. mucronatum*, G. DON (by NAKAI)<sup>(2)</sup>.

15. *R. linearifolium* var. *macrosepalum*, MAKINO. Branches stout; flowers 5 cm. in diameter, petals five-splitted, narrow, red purple, stamens 5.

16. *R. sublancoletum*, MIQUEL. Branches stout; leaves thick, almost glabrous; flowers 5 cm. in diameter, stamens 10.

---

Since the flowers of *Rhododendron* are comparatively large, the manipulation concerning their crosses is quite easy. Emasculation is done three or four days before the flower opens, and when the stigma is somewhat covered with mucus, artificial crossing may be performed. The flowering time is one of the characteristic features of every species, and though the majority of the species begin to flower between April and May, they differ slightly from each other in this respect. So frequently we have seen that while one of them has already passed out from the blossoming time, others are still in bud condition. The blooming times of *R. mucronulatum* and *R. lateritum* form an extreme contrast, for while the former comes in full bloom early spring, the latter opens the flower first in summer. Fortunately, the pollen grains of *Rhododendron* can remain active during two weeks, when preserved under room temperature. Notwithstanding all these the crossing time of these *Rhododendron* species is necessarily much limited.

---

(1) l. c.

(2) l. c.

The seeds of *Rhododendron* require about half an year to become quite ripe. It is easy to conceive that many injures will come upon the seeds during this long growing period of fruit.

Sowing has been made early spring in the room or greenhouse. The mixture of clay, moss, sand and humus is used in the pot. Seeds are generally very small, and their germination is irregular and often considerably delayed. This phenomenon has been observed more especially in the germination of  $F_1$  seeds between relatively distant species. The seedlings are very weak, and especially sensible to cold weather and dry condition. In spite of special care, many seedlings have perished away.

### Experimental results

The results obtained in a study of *Rhododendron* crosses extending over a period of seven years from 1925 to 1931 are pretty extensive. Among others the crossabilities between various species and the characters, which  $F_1$  seedlings indicate in their young stage after germinating, seemed especially to be of much interest. The data given in this paper will be limited to these subjects.

#### I. Section crosses

##### Sect. Eurhododendron $\times$ Sect. Sinenses

*R. Degronianum*  $\times$  *R. japonicum*. The flowering times of the two parents are somewhat different, so that the flowers of *R. japonicum* could only be pollinated with *R. Degronianum* pollen, and we have got only three fruits. Germination was fairly high and 148 seedlings were obtained. The cotyledon was generally pale green, but moreover some indicated indistinct variegation. The  $F_1$  plants were comparatively vigorous and intermediate between the two parents in growth habit. The condition of the contrasting characters in the parental species and in  $F_1$  is shown in table 1.

TABLE 1

Character	<i>Degronianum</i>	<i>japonicum</i>	$F_1$
Leaf habit	evergreen	deciduous	fall in the early spring
Size of leaf	large	small	intermediate
Leaf shape	long ovoid	ovoid	intermediate
Leaf color	deep green	light green	deep green
Hairy	nearly glabrous	hairy	intermediate

Neither plant has bloomed till now.

Sect. *Eurhodendron* × Sect. *Verticillatae*

*R. Degronianum* × *R. Schlippenbachii*. High morphological difference exists between the two species. The flowers of *Degronianum* were pollinated with *Schlippenbachii* pollen, but they have failed to set fruit and fallen till midsummer.

Sect. *Eurhodendron* × Sect. *Tsutsusi*

*R. Degronianum* × *R. obtusum*

*R. Degronianum* × *R. mucronatum*

*R. Degronianum* × *R. sublanceolatum*.

In these crosses the flowers of the latter were pollinated with pollen of the former and not inversely. Some of them remained alive until midsummer with no indication of development, but none set fruit.

*R. Degronianum* × *R. yedoense*

*R. Degronianum* × *R. pulchrum*.

The flowers of either of the two second parents above cited were pollinated with *Degronianum* pollen, but they have soon fallen down.

Sect. *Verticillatae* × Sect. *Rhodorastrum*

*R. Schlippenbachii* × *R. mucronulatum*. The flowers of *Schlippenbachii* were pollinated with the pollen of *mucronulatum*, but the crossing failed entirely.

Sect. *Rhodorastrum* × Sect. *Tsutsusi*

*R. mucronulatum* × *R. obtusum*

*R. mucronulatum* × *R. ripense*.

These two crosses have completely failed.

*R. mucronulatum* × *R. yedoense*. The cross was successful when the former was used as the male parent. A small number of seeds was obtained. Seeds are not sown yet.

Sect. *Sinenses* × Sect. *Verticillatae*

*R. japonicum* × *R. Schlippenbachii*. The cross was successful when the flowers of the former were used as the female parent. Abundant seeds were obtained, but they germinated poorly. Only eleven plants were grown, which died soon after, though they were normal and vigorous at first.



Sect. *Sinenses* × Sect. *Tsutsusi*

*R. japonicum* × *R. obtusum*. Six garden-varieties of *R. obtusum* have been used in this cross.

(1) Garden-variety "Sakurakirishima" (*R. obtusum* var. *latifolium*). It was successful in the cross with *R. japonicum* used as the male parent, but the fruit setting was very poor. The fruit contained only a few well developed seeds and the parthenocarpic fruits were frequently found. Cf. table 2, where the number of seeds in each fruit is given.

The germination of  $F_1$  seeds was considerably delayed and the cotyledons have emerged first one month after sowing. Various

TABLE 2

Fruit No.	Number of seeds contained
1	3
2	0
3	3
4	7
5	11
6	0
7	0
8	11
9	6
10	20
11	6
12	4

kinds of irregularities were observed in the color of cotyledon, which are due to incomplete development of normal green pigment. Eleven plants with normal green cotyledons have been obtained, the growth of which was normal but somewhat delayed. The plants of pale green cotyledons grew inactively and the majority of them died at summer after having developed two green leaves. The plants, which possessed yellowish cotyledons, rarely appeared, and died at the beginning of summer without having developed even a single leaf. Seedlings

were, however, mostly albinos and died within one or two weeks after germinating, of which some one became transparent gradually. The cotyledons of one plant were chimerically white and green, though the leaves were normally green. Of course, the development of cotyledons was correlated with the depth of color (Pl. I, fig. 3 and Pl. II). The number of  $F_1$  seedlings obtained in the experiment is given in table 3.

TABLE 3

	Color of cotyledons					
	green	pale green	yellow	variegate	white	transparent
1926	1	0	0	0	0	0
1927	0	19	2	1	79	0
1928	0	2	2	0	7	0
1929	8	12	0	0	27	2
1930	1	4	0	0	12	0
1931	1	5	0	0	8	0
Sum	11	42	4	1	133	2

Only five plants in 1927 and eight in 1929 survived over winter. The appearance of  $F_1$  plants was generally intermediate between two parents, but the growth habit resembled somewhat that of *R. japonicum*. The plants are incompletely deciduous, because their leaves fell down in early spring, when the new buds begun to emerge already. Two plants obtained in 1927 were, however, completely identical to the seedlings of the father plant, *R. japonicum*. The fact has interested the author very much; but unfortunately these paternal hybrids died at the stage of 3 cm. height.

(2) Garden-variety "Osakazuki" (*R. obtusum* var. *majus*). Only two crosses have set fruit in 1927, when *R. obtusum* was used as the female parent. Reciprocal crosses failed always, though the crossed flowers remained alive more than four months. Four kinds of colors—pale green, yellow, variegate and white—were also found in the cotyledons of  $F_1$  seedlings (Table 4).

TABLE 4

	Color of cotyledons			
	pale green	yellow	variegate	white
1928	10	4	1	43

All the plants died soon.

(3) Garden-variety "Tatsutagawashibori." A number of crosses were made; the fruits were readily set out when the flowers of *R. ob-*

*tusum* were pollinated with the pollen of *R. japonicum*. The cotyledons of seedlings, which were obtained from these crosses, are either pale green or white, as shown in table 5.

TABLE 5

	Color of cotyledons	
	pale green	white
1927	15	0
1928	2	5
1930	4	9
Sum	21	14

All the plants, however, died soon after germinating with or even without slight indication of leaf development.

(4) Garden-variety "Miyakoshibori" and "Benikirishima." Only one cross was successful, when either of the above two parents served as the female parent. A few seeds were obtained but none germinated.

(5) Garden-variety "Toyokirishima." The crosses failed always, though the fruits grew poorly in the case of *R. obtusum* ♀ × *R. japonicum* ♂.

*R. japonicum* × *R. transiens*. The crosses could easily made when *R. transiens* was used as the female parent, and a number of seeds were obtained. Color variations were also observed in the cotyledons of hybrid seedlings, as it was the case in the crosses between *R. obtusum* and *R. japonicum*. In this case, however, the plants with green cotyledons were comparatively abundant (Table 6).

TABLE 6

Cross No.	Color of cotyledons					
	green	pale green	yellow	variegate	white	transparent
1	17	32	22	3	22	0
2	0	0	3	0	0	0
3	4	5	8	0	9	1
Sum	21	37	33	3	31	1

All the plants, which had severe defect in cotyledons, could not live more than fifty days after germinating. The reciprocal crosses were also unsuccessful.

*R. japonicum*  $\times$  *R. ripense*. All crosses failed completely.

*R. japonicum*  $\times$  *R. mucronatum*. Three garden-varieties of *R. mucronatum* were used in the cross.

(1) Garden-variety "Shiroriukyu." The crosses were difficult to be done, especially in the case of *R. japonicum* as the male parent. Four kinds of color were also observed in the cotyledons of  $F_1$  seedlings as shown in table 7.

TABLE 7

	Color of cotyledons			
	green	pale green	slightly yellowish white	variegate
1927	1	56	19	6
1928	0	27	27	2
Sum	1	83	46	8

The green plants remained alive until winter, but the other died soon after germinating with or without having developed a single leaf. The seeds of reciprocal crosses, however, could not germinate at all.

(2) Garden-varieties "Riukyushibori" and "Kanokoshibori." A number of crosses were made and only a few set out fruit when *R. mucronatum* was used as the female parent. Reciprocal crosses failed completely. Variations were also observed in the color of cotyledons (Table 8).

TABLE 8

Crosses		Color of cotyledons			
		green	pale green	yellowish white	transparent
"Riukyushibori" $\times$ <i>R. japonicum</i>	1926	0	1	0	0
	1928	2	0	0	0
	1929	0	3	0	0
	1930	0	6	0	0
	Sum	2	10	0	0



TABLE 8 (Continued)

Crosses		Color of cotyledons			
		green	pale green	yellowish white	transparent
<i>R. japonicum</i> × “Riukyu- shibori”	1926	0	2	0	0
	1927	0	31	0	2
	1928	1	2	10	2
	1930	0	10	2	0
	Sum	1	45	12	4

The plants with pale green cotyledons in this cross died soon after their color has gradually changed into white.

*R. japonicum* × *R. hortense*. Two garden-varieties of *R. hortense*, “Murasakiriukyu” and “Minenomatsukaze,” were used. The crosses were made comparatively easily when the flowers of *R. hortense* were pollinated with *R. japonicum* pollen. The reciprocal crosses were on the contrary very difficult to be done, and only a few seeds were obtained.

The characteristics of cotyledon in the  $F_1$  seedlings were as follows:

TABLE 9

Crosses		Color of cotyledons				
		green	pale green	variegate	white	transparent
“Murasaki- riukyu” × <i>R. japonicum</i>	1927	0	23	0	0	2
	1931	2	5	0	1	0
	Sum	2	28	0	1	2
“Mineno- matsukaze” × <i>R. japonicum</i>	1927	0	41	0	0	0
<i>R. japonicum</i> × “Mineno- matsukaze”	1927	0	25	1	4	0
	1928	0	7	1	4	0
	Sum	0	32	2	8	0

*R. japonicum*  $\times$  *R. pulchrum*. All crossed flowers completely failed to set out fruit except a parthenocarpic one found in the cross *R. pulchrum*  $\varnothing$   $\times$  *R. japonicum*  $\sigma$ .

*R. japonicum*  $\times$  *R. linearifolium*. The cross was only successful when *R. linearifolium* was used as the female parent. A few seeds were obtained, which died soon after germinating with the indication of color defects (pale green) in the cotyledons.

*R. japonicum*  $\times$  *R. sublanceolatum*. Even a single cross could not be successful between these two species.

#### Sect. Verticillatae $\times$ Sect. Tsutsusi

The following crosses were made between the species of Sect. Verticillatae and that of Sect. Tsutsusi.

*R. Schlippenbachii*  $\times$  *R. serpyllifolium*

*R. Schlippenbachii*  $\times$  *R. obtusum*

*R. Schlippenbachii*  $\times$  *R. Kaempferi*

*R. Schlippenbachii*  $\times$  *R. transiens*

*R. Schlippenbachii*  $\times$  *R. yedoense*

*R. Schlippenbachii*  $\times$  *R. ripense*

*R. Schlippenbachii*  $\times$  *R. hortense*.

Some flowers remained alive three months after crossing and developed slightly, but all failed to set out fruit.

## II. Crossing of the species belonging to the same section

Thirty four crosses were made between species belonging to Section Tsutsusi. All these species are similar to each other morphologically, so it was to be expected that they could be crossed readily with each other, so as to give healthy hybrids. Though that expectation was not completely fulfilled, the result of crosses will be listed below.

*R. serpyllifolium*  $\times$  *R. obtusum*. Flowers of *R. obtusum* pollinated with *R. serpyllifolium* pollen set out fruits abundantly, but reciprocal crosses have given only a few seeds.

*R. serpyllifolium*  $\times$  *R. Kaempferi*. This cross has given regularly an abundance of seeds. Chlorophyll defects appeared rarely in the cotyledons of  $F_1$  hybrid, as indicated in the following table.

TABLE 10

Crosses	Color of cotyledons		
	green	pale green	variegate
<i>R. serpyllifolium</i> × <i>R. Kaempferi</i>	39	2	5
<i>R. Kaempferi</i> × <i>R. serpyllifolium</i>	28	2	0

All the plants have developed normally.

*R. serpyllifolium* × *R. yedoense*. The flowers of the latter were pollinated with the pollen of *R. serpyllifolium* in 1931, and only one fruit was set out. A number of seeds were obtained.

*R. serpyllifolium* × *R. ripense*. The cross between the two species failed completely.

*R. obtusum* × *R. lateritum*

*R. obtusum* × *R. sublanceolatum*.

The above two crosses failed completely in spite of utmost efforts.

*R. obtusum* × *R. Kaempferi*. A number of crosses were made and all set out fruit quite readily. The resulting seeds produced 152 normal plants.

*R. obtusum* × *R. transiens*. Fruit setting resulted quite regularly from this cross, and the number of seeds per fruit was abundant. Also, some seedlings died in the young stage after indicating the defect in chlorophyll formation of cotyledons. The numerical result of  $F_1$  plant in regard to the cotyledon color is shown in table 11.

TABLE 11

Crosses	Color of cotyledons				
	green	pale green	yellow	variegate	transparent
<i>R. obtusum</i> × <i>R. transiens</i>	265	132	0	16	3
<i>R. transiens</i> × <i>R. obtusum</i>	11	16	2	0	4

*R. obtusum* × *R. yedoense*. Fair differences are observed in general appearance between the two parents, and especially in the leaf habit,

but the cross was made quite readily. The resulting seeds germinated very well. Some seedlings, which were obtained in the cross between *R. obtusum* var. *latifolium*  $\times$  *R. yedoense*, however, failed to develop normal green color in the cotyledons and died soon after germinating. Table 12 indicate the numerical relation between  $F_1$  plants and cotyledon character.

TABLE 12

Crosses	Color of cotyledons			
	green	pale green	variegate	white
<i>R. obtusum</i> var. <i>latifolium</i> $\times$ <i>R. yedoense</i>	1050	164	1	7
<i>R. obtusum</i> ("Azumashibori") $\times$ <i>R. yedoense</i>	83	0	0	0
<i>R. obtusum</i> ("Hinodetsutsuji") $\times$ <i>R. yedoense</i>	over 100	0	0	0
<i>R. yedoense</i> $\times$ <i>R. obtusum</i> var. <i>latifolium</i>	599	0	0	0
<i>R. yedoense</i> $\times$ <i>R. obtusum</i> ("Hinodetsutsuji")	over 150	0	0	0

The  $F_1$  plants were somewhat vigorous and intermediate between the two parents except the growth habit, which resembles that of *R. obtusum*.

*R. obtusum*  $\times$  *R. ripense*. This cross was quite easy to be made. The  $F_1$  seedlings had generally normal green cotyledons, but some ones resulting from the cross *R. obtusum*  $\varnothing$   $\times$  *R. ripense*  $\sigma$  indicated defective chlorophyll formation in the cotyledons (Table 13).

TABLE 13

Crosses	Color of cotyledons			
	green	variegate (green and pale green)	pale green	white
<i>R. obtusum</i> $\times$ <i>R. ripense</i>	523	32	140	20
<i>R. ripense</i> $\times$ <i>R. obtusum</i>	over 1300	0	0	0

The growth habit of hybrids was somewhat identical to that of *R. obtusum*.



*R. obtusum*  $\times$  *R. hortense*. The result of this cross was almost identical to that of the preceeding one. Table 14 indicates the cotyledon color of  $F_1$  plants.

TABLE 14

Crosses	Color of cotyledons			
	green	pale green	variegate	transparent
<i>R. obtusum</i> $\times$ <i>R. hortense</i>	205	59	21	15
<i>R. hortense</i> $\times$ <i>R. obtusum</i>	13	0	0	0

*R. lateritum*  $\times$  *R. pulchrum*. Flowers of *R. pulchrum* set out fruit when pollinated by *R. lateritum*, and 141 seedlings were obtained. All the plants were quite normal and somewhat vigorous. The reciprocal cross however failed.

*R. lateritum*  $\times$  *R. linearifolium*. None have set out fruit in this cross.

*R. Kaempferi*  $\times$  *R. ripense*

*R. Kaempferi*  $\times$  *R. mucronatum*

*R. Kaempferi*  $\times$  *R. hortense*.

The above three crosses were successful in 1931. The number of seeds found in each fruit was very abundant in all cases.

*R. transiens*  $\times$  *R. ripense*. 253 good seeds were obtained in the direct cross and 135 in the reciprocal. The  $F_1$  plants were quite normal and fairly vigorous.

*R. transiens*  $\times$  *R. mucronatum*. A number of crosses were tried but all failed.

*R. transiens*  $\times$  *R. hortense*. A few seeds were obtained in this cross, from which 84 normal plants were grown out.

*R. transiens*  $\times$  *R. pulchrum*

*R. transiens*  $\times$  *R. linearifolium*

*R. transiens*  $\times$  *R. sublaceolatum*.

These crosses and their reciprocal were easily made in 1931, and a large number of seeds were obtained.

*R. yedoense*  $\times$  *R. ripense*. Both this cross and its reciprocal set out fruit readily, and abundant seeds were obtained. 559 plants of the direct

cross and 115 plants of the reciprocal grow quite normally. The growth habit of hybrids is similar to that of *R. ripense*.

*R. ripense*  $\times$  *R. hortense*. The seeds of this cross, which were regularly produced, gave 112 normal green seedlings.

*R. mucronatum*  $\times$  *R. hortense*. 691  $F_1$  plants of the direct cross and 570 of the reciprocal were grown, all of which have no indication of chlorophyll defect.

*R. mucronatum*  $\times$  *R. pulchrum*. Flowers of *R. mucronatum* pollinated with *R. pulchrum* pollen set out fruit freely, and a total of over 500 well developed seeds produced 284 seedlings, of which two failed to develop normal green color in cotyledons and died soon after germination.

*R. mucronatum*  $\times$  *R. linearifolium*. This cross failed completely.

*R. mucronatum*  $\times$  *R. subanceolatum*. The direct cross gave 54 normal hybrids, but two incompletely colored plants were found out of the total of 335 hybrids, which were produced by the reciprocal cross.

*R. hortense*  $\times$  *R. pulchrum*

*R. hortense*  $\times$  *R. linearifolium*

*R. hortense*  $\times$  *R. subanceolatum*.

All the above crosses were always successful, and they gave in every case normal green seedlings. 975  $F_1$  plants were obtained in the first case and 69 plants in the third.

*R. pulchrum*  $\times$  *R. linearifolium*. The cross was always successful, and abundant seeds were obtained in 1931.

*R. pulchrum*  $\times$  *R. subanceolatum*. This cross and its reciprocal were easily to be made. 110 seedlings of the direct cross and 77 seedlings of the reciprocal were quite normal.

*R. linearifolium*  $\times$  *R. subanceolatum*. The cross was successful without difficulty and a large number of seeds were obtained in 1931.

## Discussion

The crossability between various *Rhododendron* species here reported suggests several interesting and significant features in respect to their systematic relationship. Table 15 will give in summarized form the crossability between various *Rhododendron* species obtained in the present study. Species used as female are put above, those used as pollen parent at left.

TABLE 15

		Sect. Eurhodendron				Sect. Tsutsusi											
		<i>R. Degronianum</i>	<i>R. mucronulatum</i>	<i>R. japonicum</i>	<i>R. Schlippenbachii</i>	<i>R. serpyllifolium</i>	<i>R. obtusum</i>	<i>R. lateritum</i>	<i>R. Kaempferi</i>	<i>R. transiens</i>	<i>R. yedoense</i>	<i>R. ripense</i>	<i>R. mucronatum</i>	<i>R. hortense</i>	<i>R. pulchrum</i>	<i>R. linearifolium</i>	<i>R. sublancoelatum</i>
Sect. Eurhodendron	<i>R. Degronianum</i>	/	△			-					-		-				-
Sect. Rhodorastrum	<i>R. mucronulatum</i>	/		-		-					+	-					
Sect. Sinenses	<i>R. japonicum</i>		/	-		△				△			△	△		△	-
Sect. Verticillatae	<i>R. Schlippenbachii</i>	-	⊙	/	-	-	-	-	-	-	-	-	-	-	-	-	-
Sect. Tsutsusi	<i>R. serpyllifolium</i>			-	/	+		△		+	-						-
	<i>R. obtusum</i>		-	-	+	/	-	⊙	△	⊙	⊙		⊙				-
	<i>R. lateritum</i>					-	/								+	-	
	<i>R. Kaempferi</i>			-	△	⊙		/			+	+	+				
	<i>R. transiens</i>			-	△						⊙	-	⊙	+	+	+	
	<i>R. yedoense</i>		-	-	△			/		⊙	⊙	/	⊙				
	<i>R. ripense</i>		-	-	△		+	⊙	⊙	⊙	/		⊙				
	<i>R. mucronatum</i>		△				+	-				/	⊙			-	△
	<i>R. hortense</i>		△	-	△		+	+			⊙	⊙	/	⊙	+	⊙	
	<i>R. pulchrum</i>		-						+			△	⊙	/	+	⊙	
	<i>R. linearifolium</i>		-					-	+			-	+	+	/	+	
	<i>R. sublancoelatum</i>		-			-			+			⊙	⊙	⊙	+	/	

⊙...set fruit and give normal F<sub>1</sub> seedlings; △...set fruit and give some abnormal F<sub>1</sub> seedlings; +...set fruit (F<sub>1</sub> seedlings unknown); -...failed to cross.

Thirty-four crosses were tried between twelve species belonging to Section Tsutsusi, of which the majority were made quite easily. The complete failure of crossing was found only in five cases, viz. *R. obtusum* × *R. lateritum*, *R. obtusum* × *R. sublancoelatum*, *R. serpyllifolium* × *R. ripense*, *R. transiens* × *R. mucronatum* and *R. mucronatum* × *R. linearifolium*, though the first two crosses were done by

MIYAZAWA (1922)<sup>(1)</sup> with success. In addition to my result, he also observed the high crossability between *R. obtusum* and *R. linearifolium*. From these experimental results we may see that the *Rhododendron* species belonging to Section Tsutsusi can be crossed easily to each other. Many instances of species hybridization within Section Eurhodendron, Osmothamnus and Azaleastrum were described by FOCKE in his famous "Pflanzenmischlinge."<sup>(2)</sup> Recently SAX (1930)<sup>(3)</sup> and NAKAMURA (1931)<sup>(4)</sup> proved that the pairing of chromosomes in some intra-sectional hybrids is quite normal. So it is very probable that the crossability between different species within the same section of *Rhododendron* is more or less complete.

A number of hybrids between different sections were often reported. For instance, as early as 1838 a cross between *R. luteum* and *R. canadense* was described.<sup>(5)</sup> FOCKE<sup>(6)</sup> gave some examples of the hybrids between the following sections; Sect. Eurhodendron  $\times$  Sect. Azaleastrum, Sect. Eurhodendron  $\times$  Sect. Rhodorastrum, Sect. Eurhodendron  $\times$  Sect. Tsutsusi and Sect. Sinenses  $\times$  Sect. Verticillatae. Recently a cross between the species belonging to different sections was made by FRASER, i.e. the cross *R. japonicum* (Sect. Sinenses)  $\times$  *R. canadense* (Sect. Rhodora).<sup>(7)</sup> Three additional cases of intersectional crosses are reported in this paper between *R. japonicum* (Sect. Sinenses) and *R. Degronianum* (Sect. Eurhodendron), between *R. japonicum* and *R. Schlippenbachii* (Sect. Verticillatae), and also between *R. japonicum* and several species belonging to Sect. Tsutsusi. Moreover, the author obtained in 1931 a number of seeds in the cross between *R. mucronulatum* (Sect. Rhodorastrum) and *R. yedoense* (Sect. Tsutsusi), so that a new case might perhaps be added in the near future when they will grow. Some interest is found in the crossability of *R. japonicum* against the species in Sect. Tsutsusi. As already mentioned, their crosses were very difficult to be done, especially in the case *R. japonicum* as the female parent. This fact shows certainly that the systematic relationship between *R. japonicum* and the species in Sect. Tsutsusi is somewhat distant.

---

(1) Japan. Jour. Genet., **1**, 1922, 150.

(2) Pflanzenmischlinge, 1881, 233.

(3) Amer. Jour. Bot., **17**, 1930, 247.

(4) Jour. Soc. Trop. Agr., **3**, 1931, 103.

(5) WILSON, E. H. and REHDER, A.: A monograph of the Azaleas, 1921.

(6) l. c.

(7) WILSON and REHDER (l. c.).



Some negative results of intersectional crosses were also reported by MIYAZAWA.<sup>(1)</sup> He failed, for instance, completely to cross *R. obtusum* (Sect. Tsutsusi) with *R. Degronianum* (Sect. Eurhodendron), and also with two species of Sect. Verticillatae. In the following crosses the author also got exactly similar results, viz. *R. Degronianum* (Sect. Eurhodendron)  $\times$  *R. Schlippenbachii* (Sect. Verticillatae), *R. Schlippenbachii*  $\times$  *R. mucronulatum* (Sect. Rhodorastrum), several species in Sect. Tsutsusi  $\times$  *R. Degronianum* and *R. Schlippenbachii*.

It seems very probable that the number of seeds contained in each fruit, which is produced by the cross of two different species, is correlated approximately with their parental affinity, namely, the closer their relation, the greater the number of seeds produced. This fact will want, however, further study.

Another interesting phenomenon is the chlorophyll defect in cotyledons of hybrids produced by the species cross. MIYAZAWA<sup>(2)</sup> has found first the color irregularities of cotyledons of seedlings after selfing or crossing of some species and varieties in Sect. Tsutsusi. Recently it was reported by NAKADA that he obtained some albinos by the cross *R. lateritum*  $\varnothing$   $\times$  *R. japonicum*  $\sigma$ .<sup>(3)</sup> Such abnormality was observed always by the author in the cotyledons of intersectional hybrids between *R. japonicum* and the species in Sect. Tsutsusi. In addition to them a few instances of similar kind in the crosses of species belonging to Sect. Tsutsusi (Table 15) were seen. A remarkable difference in color irregularity of cotyledons is recognized between the inter- on one hand and intrasectional crosses on the other. In the summary of crosses in table 16 a comparison is made of the numerical relation.

TABLE 16

Crosses		Color of cotyledons					
		green	pale green	yellow	variegated	white	transparent
Intersectional	<i>R. obtusum</i> $\times$ <i>R. japonicum</i>	11	73	8	2	190	2
	<i>R. transiens</i> $\times$ <i>R. japonicum</i>	21	37	33	3	31	1
	<i>R. mucronatum</i> $\times$ <i>R. japonicum</i>	4	138	—	8	58	4
	<i>R. hortense</i> $\times$ <i>R. japonicum</i>	2	101	—	2	9	2

(1) l. c.

(2) l. c.

(3) The fact was kindly announced to the author by Mr. F. KURASHIGE at the Kanagawa Agricultural Experiment Station.

TABLE 16 (Continued)

Crosses		Color of cotyledons					
		green	pale green	yellow	variegated	white	transparent
Intrasectional	<i>R. serpyllifolium</i> × <i>R. Kaempferi</i>	67	4	—	5	—	—
	<i>R. obtusum</i> × <i>R. transiens</i>	276	148	2	16	—	7
	<i>R. obtusum</i> × <i>R. yedoense</i>	over 1900	164	—	1	7	—
	<i>R. obtusum</i> × <i>R. ripense</i>	over 1800	140	—	32	20	—
	<i>R. obtusum</i> × <i>R. hortense</i>	218	59	—	21	—	15
	<i>R. mucronatum</i> × <i>R. pulchrum</i>	282	2	—	—	—	—
	<i>R. mucronatum</i> × <i>R. subanceolatum</i>	387	2	—	—	—	—

It is a characteristic of intersectional hybrid that the degree of chlorophyll defect is of somewhat wide range, and that the normal green plants very rarely appear.

The chlorophyll defect in seedlings has been observed very often in the crosses of *Oenothera* species.<sup>(1)(2)</sup> Also in the cross between *Hypericum quadrangulum* and *H. acutum* FARENHOLZ<sup>(3)</sup> found besides normal green hybrids some yellowish ones, which died soon after. MANGELSDORF and EAST<sup>(4)</sup> crossed *Fragaria vesca* with *Potentilla nepalensis* and obtained only two seedlings; both were pale yellowish green, and died two weeks after germination with no indication of plumule development. It is well known that in respect to the mechanism, how the chlorophyll defect will be produced in the hybrids between two normal green plants, there are various opinions,<sup>(5)(6)</sup> but the author's results will not be able to give them a decision.

Some paternal hybrids were obtained in the cross *Rhododendron obtusum* ♀ × *R. japonicum* ♂, the discussion of which will be reserved for another paper.

(1) DE VRIES (l. c.).

(2) RENNER (l. c.).

(3) l. c.

(4) l. c.

(5) RENNER (l. c.).

(6) NOACK: Zeitschr. f. ind. Abst. und Vererb., **59**, 1931, 77.

### Summary

1. Sixteen species of *Rhododendron*, which are cultivated at present in Japan, were crossed to each other.

2. The species belonging to Section Tsutsusi can be crossed to each other with ease.

3. The following four intersectional crosses were successfully done :

*R. japonicum* (Sect. Sinenses)  $\times$  *R. Degronianum* (Sect. Eurhodendron),

*R. japonicum*  $\times$  *R. Schlippenbachii* (Sect. Verticillatae),

*R. japonicum*  $\times$  several species in Sect. Tsutsusi,

*R. mucronulatum* (Sect. Rhodorastrum)  $\times$  *R. yedoense* (Sect. Tsutsusi).

4. Several kinds of chlorophyll defect are observed in the cotyledon of hybrids, especially in respect to the intersectional hybrids between *R. japonicum* and the species in Sect. Tsutsusi.

---

### Explanation of Plates I–II

#### PLATE I

- Fig. 1. *Rhododendron japonicum*, SURING.  
Fig. 2. *Rhododendron obtusum*, PLANCH.  
Fig. 3. Hybrid seedlings between *R. obtusum* and *R. japonicum*. At left, plants with normal green cotyledons; at right, plants with chlorophyll defects in cotyledons.

#### PLATE II

Color variation in the cotyledons of hybrid seedlings between *R. obtusum* and *R. japonicum*. Figs. 4–5 are the parental seedlings; figs. 6–11 are hybrid seedlings. All figures 4 times natural size.

- Fig. 4. *R. obtusum*.  
Fig. 5. *R. japonicum*.  
Fig. 6. Normal green hybrid.  
Fig. 7. Pale green hybrid.  
Fig. 8. Hybrid with yellow cotyledons.  
Fig. 9. Hybrid with variegated cotyledons.  
Fig. 10. Albino.  
Fig. 11. Albino, the cotyledons of which become transparent gradually.
-



PLATE I



Fig. 2 (P ♀)

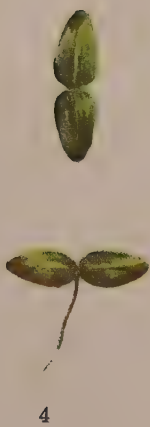


Fig. 1 (P ♂)



Fig. 3 (F₁)









# Effect of seed-formation on the rate of respiration of the fruit of the Japanese persimmon or kaki (*Diospyros Kaki* L. f.)<sup>(1)</sup>

By Kumaichi MATSUMOTO

---

With 1 text-figure

---

(Received February 6, 1932)

## Introduction

The effect of seed-formation upon the characters of the fruit of kaki has been the subject of many investigations. TAMARI (15) reported as early as 1901 on the parthenocarpical fruiting of some varieties of kaki. HUME (9) studied the effect of pollination on the color and the texture of the fruit flesh and on the time of ripening etc. The studies were made with certain varieties which are classified as pollination variants (10). HATORI (7) described the correlation between seed-formation and the formation of "goma" or browning of the tannin sacs in the variety Kubo, while TOKUGAWA (16) stated that the seed formation has some effect on the non-astringency or "goma" formation of kaki fruit but that it is not an efficient cause. Recently NOGUCHI reported (13), as an example of metaxenia, the effect of the pollination upon the shape and the degree of astringency of a fruit. From these and many other studies, it is generally recognized that in certain varieties of kaki a seeded fruit has distinctly different characters from a seedless one. However, quite a few of these investigators extended their studies to the effect of seed-formation upon the metabolic processes of the fruit.

While dealing with kaki fruits, the writer observed that in one variety, the seedless fruit had better keeping qualities than the seeded individuals in the case of the non-astringent varieties. This fact seems to be largely due to the difference in the rate of respiration. Generally, fruits in the market and in storage are subjected to many variable

---

(1) Contribution No. 15 from the Institute of Plant Industry, Kyoto Imperial University.

conditions, all of which probably affect the rate of the processes involved in deterioration. Among these, respiration is probably the principal factor in the deterioration of fresh fruits. There are many internal and external factors that affect the rate of respiration of kaki fruits, but the writer has been strongly impressed from his observation with the idea that there might be a close correlation between seed-formation and the rate of respiration.

The object of the studies reported in the present paper was primarily to ascertain to what extent the seeded fruit differs in the intensity of respiration from the seedless fruit, by means of comparing the weight of  $\text{CO}_2$  expired by these fruits. Also some studies were made to find the cause of this difference.

This report consists chiefly of the results of experiments carried out during three seasons 1928, 1929 and 1930, with a variety Kubo (pollination-variant), and two seasons 1929 and 1930 with two varieties Fuyu and Jiro (non-astringent pollination-constants)<sup>(1)</sup>. Two astringent varieties, Hagakushi and Yotsumizo (astringent pollination-constants)<sup>(1)</sup> were also used in the 1930 and 1931 experiments respectively.

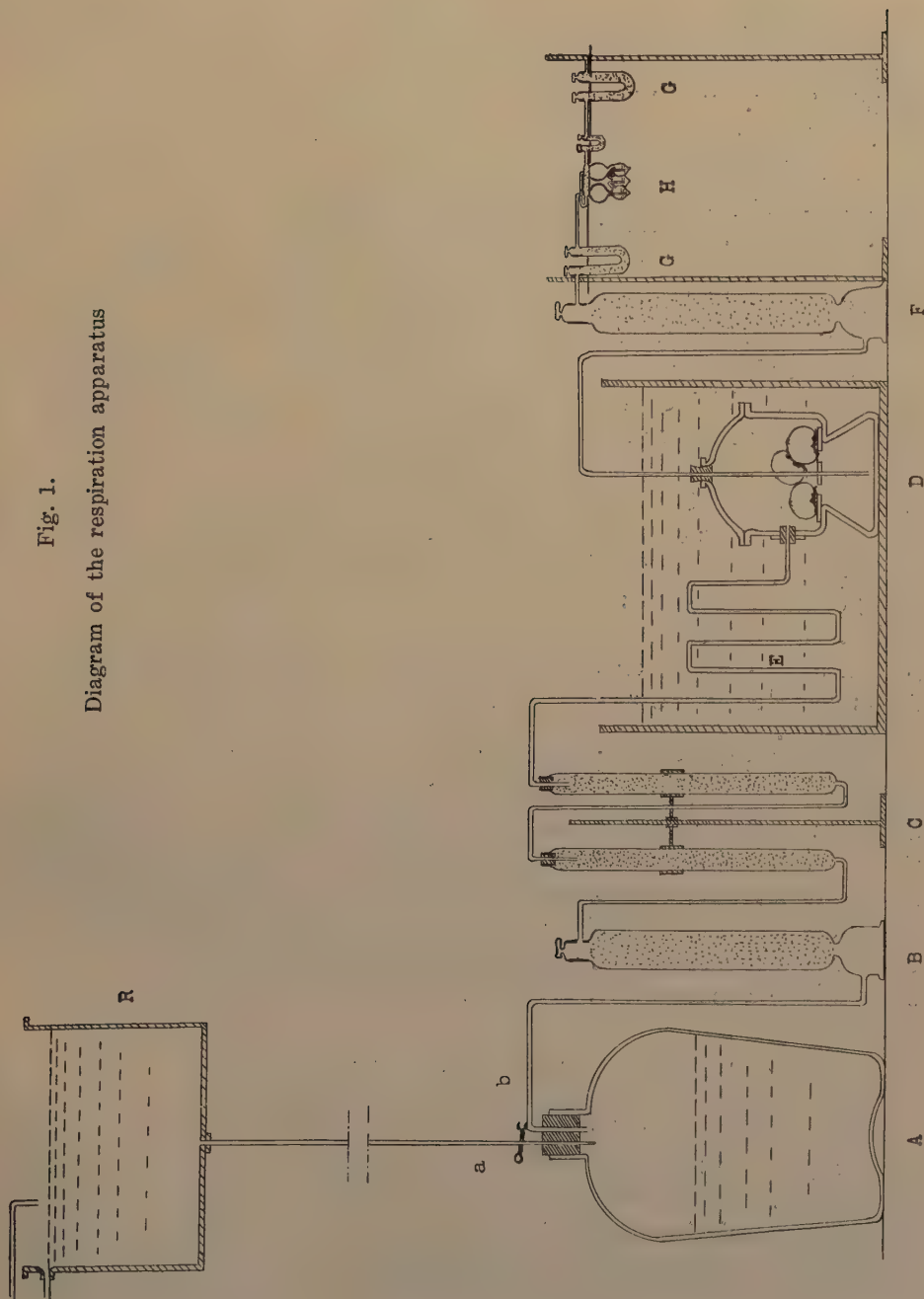
## Experimental Procedure

There are two types of procedure that are commonly used to measure the  $\text{CO}_2$  emitted as the product of respiration. These are the current and the non-current air type. The apparatus which was designed for this experiment belongs to the former type, as is shown as the diagram in Figure 1. First of all, there is an arrangement to regulate the rate of the flow of air through the series of vessels. The bottle "A" served to replace air with water. A desired volume of water in a certain time was dropped from the reservoir "R" into bottle "A" through tube "a". At the same time, therefore, the same volume of air was pressed out through tube "b" into the remaining part of the train. In this way, a regular continuous current of air throughout the apparatus was maintained. Some soda lime was placed in the bottle "C" to remove  $\text{CO}_2$  from the air that entered from the outside. Bottles "B" and "F" and the U-tubes "G" hold calcium chloride to absorb moisture contained in the air. Tube "E" and the

---

(1) The term "non-astringent" or "astringent pollination-constant" indicates a variety which bears non-astringent or astringent fruits respectively either with or without pollination.

Fig. 1.  
Diagram of the respiration apparatus



respiration chamber "D" were placed beneath the surface of the water in an electrically controlled thermostat. Therefore the temperature of the air flowing into the respiration chamber was always regulated at the tube "E". "H" indicates a potash bulb in which about 50 per cent. of KOH solution was placed to absorb  $\text{CO}_2$  expired by the fruits in the respiration chamber. The potash bulb was changed every 12 hours and the amount of  $\text{CO}_2$  absorbed was measured by weighing this bulb. The room where this apparatus was placed was kept dimly dark during the experiments, and also the thermostat was covered with black cloths to shield the respiration chamber from light.

The fruits that were used in these experiments were picked at the commercial ripening stage from an individual tree 8 years old after planting in the University farm. Special care was taken in the picking and handling of these samples, and within a few hours after picking, the fruits were placed in the respiration chamber and the experiment started as soon as the sample reached the desired temperature and the measurement was continued for 7 days. In the case of Fuyu and Jiro, seeded fruits were obtained by artificial crossing, the pollen of Shogatsu being used, and seedless fruits were raised by interference with pollination. Kubo, on the other hand, bore abundant fruits freely, both seeded and seedless, on an individual tree. Therefore both sets of fruits could easily be selected with a high degree of accuracy by their appearance.

The fruits to be used in one series of experiments, both seeded and seedless, were of as nearly the same weight as possible. But a number of fruits could hardly be matched on account of the wide difference in their size, especially in the case of the non-astringent varieties, and seeded fruits were nearly always much larger than seedless. Details of the experimental conditions, such as the length of each experiment, the condition of the fruits used, and the temperature of the respiration chamber etc. are recorded in Table 1.

## Experimental Results and Discussion

Before discussing the experiments it may be appropriate to summarize the results briefly. As shown in Tables 2-5, in all four varieties there was a significant difference between seeded and seedless fruits in the rate of emission of  $\text{CO}_2$  in all the seasons when the experiments were made. Practically in every experiment, and also in the daily record, the seeded fruit expired  $\text{CO}_2$  far in excess of that of the seedless



fruit under similar environmental conditions. There were only two exceptions to this in the daily record, the third day of 1928 and the second day of 1929, when the seedless fruit of the Kubo variety showed a greater emission of  $\text{CO}_2$  than the seeded.

TABLE 1  
Details of experimental conditions

Varieties	Length of exp't	Number of fruit used	Gm. of fruit used	Number of seeds in fruits	Temp. used for exp't (C)	Air passed in a day (liter)
Kubo (1928) Seeded	168 hours	26	2530	many	15—18	22
" " Seedless	"	48	3102	0	15—18	22
Kubo (1929) Seeded	168 "	13	1070	53	25	32
" " Seedless	"	17	1070	0	25	32
Kubo (1930) Seeded	168 "	14	1003	62	25	32
" " Seedless	"	20	1021	0	25	32
Jiro (1929) Seeded	168 "	4	992	28	24	32
" " Seedless	"	5	945	0	24	32
Jiro (1930) Seeded	168 "	5	941	19	25	32
" " Seedless	"	5	1009	0	25	32
Fuyu (1929) Seeded	168 "	3	920	20	25	32
" " Seedless	"	4	830	0	25	32
Fuyu (1930) Seeded	168 "	5	969	17	25	32
" " Seedless	"	4	620	0	25	32
Hagakushi (1930) Seeded	168 "	4	725	11	25	32
Hagakushi (1930) Seedless	"	4	895	0	25	32
Yotsumizo (1931) Seeded	168 "	7	808	17	25	32
Yotsumizo (1931) Seedless	"	8	809	0	25	32

TABLE 2  
Rate of emission of  $\text{CO}_2$  by fruits of Kubo, one of the pollination-variants

Hours from start	1928		1929		1930	
	Mg. $\text{CO}_2$ per hour per kg. fruits		Mg. $\text{CO}_2$ per hour per kg. fruits		Mg. $\text{CO}_2$ per hour per kg. fruits	
	Seeded	Seedless	Seeded	Seedless	Seeded	Seedless
1st 24 hours	14.5	12.8	25.0	23.6	32.6	22.7
2nd "	17.2	16.5	21.1	21.2	28.7	20.5
3rd "	13.6	15.0	15.5	19.5	27.5	15.0
4th "	13.7	12.2	18.2	17.8	24.2	21.3
5th "	13.1	13.0	20.5	14.7	24.7	18.3
6th "	14.1	9.7	19.5	15.1	25.8	16.6
7th "	13.3	11.8	20.9	15.5	28.9	20.5

TABLE 3

Rate of emission of CO<sub>2</sub> by fruits of Jiro, a non-astringent pollination-constant

Hours from start	1929		1930	
	Mg. CO <sub>2</sub> per hour per kg. of fruit		Mg. CO <sub>2</sub> per hour per kg. of fruit	
	Seeded	Seedless	Seeded	Seedless
1st 24 hours	26.9	23.7	28.4	24.3
2nd "	23.5	21.2	24.0	23.0
3rd "	22.7	21.2	22.7	19.1
4th "	16.8	16.1	22.1	16.8
5th "	18.2	16.5	19.0	15.2
6th "	17.5	17.0	19.6	15.8
7th "	18.1	16.2	19.3	14.4

TABLE 4

Rate of emission of CO<sub>2</sub> by fruits of Fuyu, a non-astringent pollination-constant

Hours from start	1929		1930	
	Mg. CO <sub>2</sub> per hour per kg. of fruit		Mg. CO <sub>2</sub> per hour per kg. of fruit	
	Seeded	Seedless	Seeded	Seedless
1st 24 hours	27.1	26.1	26.7	22.1
2nd "	22.6	21.9	24.2	21.6
3rd "	18.9	missed	20.2	17.4
4th "	16.8	16.6	18.6	15.7
5th "	15.5	15.9	17.3	14.4
6th "	14.4	16.6	17.2	13.9
7th "	12.9	13.8	16.6	13.3

TABLE 5

Rate of emission of CO<sub>2</sub> by fruits of Hagakushi,  
an astringent pollination-constant

Hours from start	1930	
	Mg. CO <sub>2</sub> per hour per kg. of fruit	
	Seeded	Seedless
1st 24 hours	22.4	21.3
2nd "	21.9	20.0
3rd "	18.6	16.7
4th "	17.0	15.4
5th "	15.7	14.3
6th "	14.7	12.5
7th "	14.0	13.4

Yotsumizo, however, shows somewhat different features from the others, as is shown in Table 6. In this case the difference between the two could hardly be distinguished.

TABLE 6

Rate of emission of CO<sub>2</sub> by fruits of Yotsumizo,  
an astringent pollination-constant

Hours from start	1930	
	Mg. CO <sub>2</sub> per hour per kg. of fruit	
	Seeded	Seedless
1st 24 hours	34.6	35.9
2nd    ,,	27.1	27.9
3rd    ,,	23.8	26.6
4th    ,,	17.9	17.3
5th    ,,	27.9	25.3
6th    ,,	22.9	20.9
7th    ,,	24.3	25.7

Careful examination of these data showed that there was also a general tendency for both seeded and seedless fruits to respire more intensely at the beginning of the experiments, and then the rate of respiration gradually decreased as the experiment progressed. This fact is quite analogous to that observed by GUSTAFSON (6) in his experiment with tomato fruit.

For convenience in comparing the respiratory intensity among different varieties, the writer presents Table 7, which was prepared from the result of the 1930 and 1931 experiments. In this table, Kubo shows the highest intensity, Jiro, Fuyu and Hagakushi follow in turn, and Yotsumizo shows the lowest rate. Such a comparison as that made in Table 7 may not be strictly reasonable, because it is not a comparison of the rates of respiration throughout the growing season of the fruits but only in the period of maturity, it being very difficult, if not impossible, to select fruits of different varieties at the same stage of maturity. However, the general features of the respiratory activity can be seen even from this table.

TABLE 7  
Comparison of the rate of emission of CO<sub>2</sub> in four different varieties

Variety	Seeded		Seedless		Ratio
	Mg. CO <sub>2</sub> per kg. fruits for 7 days	Mg. CO <sub>2</sub> per kg. fruits per day	Mg. CO <sub>2</sub> per kg. fruits for 7 days	Mg. CO <sub>2</sub> per kg. fruits per day.	$\frac{\text{Seeded}}{\text{Seedless}}$
Kubo	4,620.8	660.1	3,240.7	462.9	1.426
Jiro	3,723.0	531.9	3,088.4	441.2	1.206
Fuyu	3,330.1	482.9	2,841.9	405.9	1.189
Hagakushi	2,935.1	426.4	2,728.8	389.8	1.094
Yotsumizo	4,284.0	612.0	4,310.4	615.7	0.994

Quite interesting facts can be observed in Table 7, where it is seen that non-astringent varieties show a wide range of CO<sub>2</sub> production, and that Kubo, a pollination-variant, shows the widest range. On the other hand astringent pollination-constants such as Hagakushi and Yotsumizo show the least emission of CO<sub>2</sub>. From these facts it may reasonably be supposed that the seeds in both non-astringent and astringent fruit have some effect on the intensity of fruit respiration but in different degrees.

At any rate, the question arises, why does such a distinct difference occur in the rate of emission of CO<sub>2</sub> in consequence of the presence or absence of seeds in fruit? A definite answer can hardly be given from the present experiments; further intensive studies in this field are necessary.

For the purpose of reference, however, analysis of the sugars in these fruits have been made and the results are as shown in Table 8.

TABLE 8  
Sugar analysis of fresh fruits

	Water in %	Reducing sugar in %	Non-reducing sugar in %	Total sugar in %
Kubo				
1929 { Seeded	79.03	12.26	0.25	12.52
{ Seedless	80.18	11.41	0.69	12.14
1930 { Seeded	81.61	11.15	0.51	11.69
{ Seedless	81.83	11.29	0.70	12.03
Fuyu				
1930 { Seeded		14.14	1.07	16.23
{ Seedless		13.12	1.54	14.80
Jiro				
1930 { Seeded		16.71	0.54	17.30
{ Seedless		14.34	0.85	15.26



There is a little more reducing sugar in seeded fruit than in seedless in 1929 Kubo, but the reverse is true in the case of the 1930 Kubo. It is, therefore, rather appropriate to say that there is practically no difference in reducing sugar content. In the case of Fuyu and Jiro more reducing sugar is present in seeded than in seedless fruits, while seedless fruit contains a little more non-reducing sugar in every case. But these facts would hardly be taken into consideration in finding an answer to the above question.

According to KAKESITA (11) kaki fruit produced some acetaldehyde and ethyl alcohol as a product of intramolecular respiration when the fruits were treated with hot water for artificial removal of astringency. Also he detected these substances under natural conditions in a fruit of Zenjimar, a non-astringent variety. In the light of these facts, the writer tried experimentally the effect of these substances on the intensity of respiration. An experiment was made with unripe fruits of Yotsumizo and Fuyu from the 16th to the 23rd of September, and the other with mature fruits of Fuyu from the 29th of September to the 7th of October in 1931. The results are summarized in Tables 9 and 10.

TABLE 9

Effect of acetaldehyde on the respiration intensity of unripe fruits.  
CO<sub>2</sub> in mg. per hour per kg. of the fruit

	Yotsumizo		Fuyu
	Seedless (no seed in 5 fruits)	Seeded (7 seeds in 5 fruits)	Seeded (17 seeds in 5 fruits)
Before treatment			
1st 24 hours	16.9	26.8	23.0
2nd 24 h's	18.1	24.6	20.8
3rd 24 h's	12.6	24.8	28.9
After treatment with acetaldehyde			
1st 24 hours	51.2	44.2	41.6
2nd 24 h's	44.2	43.2	34.3
3rd 24 h's	41.9	38.7	29.8

TABLE 10

Effect of acetaldehyde and ethyl alcohol on the respiration intensity of fully matured fruit of Fuyu

	CO <sub>2</sub> in mg. per hour per kg. of fruit		
	(With 22 seeds in 5 fruits)	(With 23 seeds in 5 fruits)	(With 22 seeds in 5 fruits)
Before treatment			
1st 24 hours	31.9	29.7	31.1
2nd „	22.9	22.6	26.0
3rd „	23.7	22.3	22.6
After treatment	No treatment	Treated with acetaldehyde	Treated with alcohol
1st 24 hours	20.7	26.8	18.1
2nd „	18.5	22.7	18.7
3rd „	18.6	20.7	17.8

In these experiments, after the CO<sub>2</sub> had been measured for three days, the samples were taken out from the respiration chamber and placed in a desiccator, of about 3 liters capacity, with 5 c.c. of 15 per cent. acetaldehyde or 10 c.c. of 15 per cent. ethyl alcohol in it, and kept there tightly covered at about 15° C. for two hours. After the treatment, the fruits were exposed to the air for 16 hours and then put back into the respiration chamber and the measurement of CO<sub>2</sub> was begun again.

From the above tables, it is clear that acetaldehyde has some power to accelerate the respiration intensity of immature kaki fruit, while its effect on fully matured fruit is rather less in degree. Alcohol, on the other hand, did not show any stimulating effect so far as this experiment is concerned.

The fact that catalase is of practically universal occurrence in living tissue suggests that this enzyme probably plays an important rôle in metabolic processes. APPLEMAN (2), one of several authors who have studied this subject, has expressed the view that it may play some part in the process of respiration, and in his work on potato juice he has stated that catalase activity shows a striking effect on the respiratory

intensity in the tuber. According to ASO (3) three kinds of enzymes are present in kaki fruit. The stimulating effect of these on the respiratory intensity, therefore, may reasonably be taken into consideration, but it is not yet known at present how these are distributed in kaki fruit and under what conditions.

Other investigators, however, hold that the enzyme is not concerned in the process of oxidation. DRAIN (5) worked with apples and has stated that respiration rate and catalase activity are not closely correlated in apple varieties. According to HEINICKE (8), in the production of carbon dioxide by apple twigs there is no consistent relationship between respiratory intensity and catalase activity.

SWINGLE (14) and NIXON (12) observed an interesting feature in date palms, viz. that the kind of the pollen used for fecundation has a direct effect on the size, the rate of development and the time of ripening of the fruit derived from the ovarial tissue of the mother plant. SWINGLE proposed the term "metaxenia" for this phenomenon. As the simplest and most probable theory to explain metaxenia, he states that the embryo or endosperm or both of them secrete hormones, or soluble substances analogous to them, which diffuse out into the tissues of the mother plant that constitute the seed and fruit and there exert a specific effect on these tissues varying according to the particular male parent used to fecundate the embryo and endosperm.

If this explanation can be applied to kaki fruit, the problem of the difference between seeded and seedless fruits in respiration intensity as discussed here, could easily be solved. This theory is therefore of deep interest to those of us who are working in this field but we have as yet no data to be reported in the present paper. However some studies on these problems are now in progress in this laboratory.

### Summary

1. The respiratory intensity of kaki fruits was represented by the rate of emission of  $\text{CO}_2$  by the fruits under controlled conditions.

2. A fruit with seeds expires a much larger amount of  $\text{CO}_2$  than a fruit without seed in the case of certain varieties such as Kubo, pollination-variant, and Fuyu and Jiro, non-astringent pollination-constants, under similar environmental conditions.

3. Sugar analysis of kaki fruits gives little information to explain the correlation between seed-formation and respiratory intensity.

4. The respiratory processes of kaki fruits were markedly accelerated by treatment with acetaldehyde, the action being especially evident in the immature stage. Alcohol did not show any evidence of stimulating effect so far as the present experiment was concerned.

### Acknowledgment

The writer is deeply indebted to Prof. Akio KIKUCHI for guidance and suggestions throughout the study of this problem, and also wishes to acknowledge his indebtedness to Prof. Isawo NAMIKAWA for valuable advice and suggestions.

---



## Literature cited

1. ANONYMOUS: The studies on the varieties of Japanese kaki. (Japanese). Imp. Agr. Exp. Sta. Spec. Rep. No. **28**, 1912.
  2. APPLEMAN, C. O.: Relation of oxidases and catalase to respiration in plants. Amer. Jour. Bot. **3**: 223-233, 1916.
  3. ASO, K.: The oxidizing enzymes in kaki fruits. (Japanese). Bot. Mag. **15**: 166, 1900.
  4. BLACKMAN, F. F.: Analytic studies in plant respiration. 1. The respiration of a population of senescent ripening apples. Proc. Roy. Soc. London, B. **103**: 412-445, 1928.
  5. DRAIN, B. D.: Temperature and respiratory enzymes of apples. Bot. Gaz. **82**: 183-194, 1926.
  6. GUSTAFSON, F. H.: Growth studies on fruits. Respiration of tomato fruits. Plant Physiol. **4**: 349-356, 1929.
  7. HATORI, S.: Influence of the seed-formation on the quality of fruits in kubo-gaki, one of the kaki variety. (Japanese). Agr. and Hort. **2**: 249-264, 1926.
  8. HEINICKE, A. J.: Catalase activity in dormant apple twigs: its relation to the condition of the tissue, respiration, and other factors. Cornell Univ. Agr. Exp. Sta. Memoir **74**, 1924.
  9. HUME, H. H.: Effect of pollination on the fruit of *Diospyros Kaki*. Proc. Soc. Hort. Sci. **88-93**, 1913.
  10. ———: A kaki classification. Jour. Hered. **5**: 400-406, 1914.
  11. KAKESITA, K.: Quantitative change of acetaldehyde and ethyl alcohol formed in some fruits during storage and ripening. (Japanese). Agr. and Hort. **5**: 1151-1161, 1930.
  12. NIXON, R. W.: Immediate influence of pollen. Jour. Hered. **19**: 241-256, 1928.
  13. NOGUCHI, Y.: An example of metaxenia. (Japanese). Kwagaku. **1**: 365-366, 1931.
  14. SWINGLE, W. T.: Metaxenia in the date palm. Jour. Hered. **19**: 257-268, 1928.
  15. TAMARI, K.: Studies of kaki fruit. (Japanese). Dainippon Nokai-Ho, No. **233**, 1910.
  16. TOKUGAWA, Y.: On the de-astringency in the fruits of *Diospyros Kaki*. (Japanese). Bot. Mag. **33**: 387, 1919.
-



# On the flower types of *Diospyros Kaki* L.f.<sup>(1)</sup>

By Isawo NAMIKAWA, Makoto SISA and Kehtarow ASAI

---

With 23 text-figures

---

(Received February 3, 1932)

The commonly grown Japanese varieties<sup>(2)</sup> of kaki are generally thought to be monoecious. But some varieties bear pistillate flowers only and some others both pistillate and staminate flowers regularly. YASUI (29) mentioned a number of exceptional cases of monoecious character, and accounted for the habit of bearing flowers of different sex, by stating that *Diospyros Kaki* was naturally monoecious, and that it was in the process of losing that character, and producing staminate flowers, under cultivation. According to CONDIT (2), "seedling trees are very unreliable in the production of blossoms, bearing male flowers is sporadic on some trees and regular on others." If either pistillate or staminate flowers occur unmixed on a tree at a certain age of a variety, the variety or the individual may be practically taken as dioecious, though it can not be said to be really dioecious if staminate and pistillate flowers are produced separately at different ages on one tree. For convenience, the term "apparently dioecious" is used in this paper according to the sexuality evident at the present time in the cultural varieties investigated here. Some of the varieties grown in an experimental orchard of this college bear pistillate flowers only, and others such as Hanagoshō, Zenjimarū, etc., bear both staminate and pistillate flowers on each tree. That is to say, the former may be called apparently dioecious, and the latter monoecious.

The production of the perfect flower on this tree is reported by CONDIT (2) and others. YASUI (29) also mentioned in her work that some had pistillate, staminate, and perfect flowers, and produce also

---

(1) Contribution No. 11 from the Institute of Plant Industry, Agricultural College, Kyoto Imperial University.

(2) The term "variety" is used here in the horticultural sense. The horticultural variety is propagated asexually and the different individuals of a named variety are to be understood as of common origin from a single individual.

two types of fruits from the two kinds of flowers. But no detailed descriptions of hermaphroditic flowers have been given. Zenjimarū, a pollination variant variety bearing round to slightly oblong fruits, occasionally produces some unusual fruits, which are smaller in size than normal and oblong in shape. Besides normal pistillate flowers, this variety bears plenty of staminate flowers, in some of which the pistillode is of good size. From these characteristics, the under-sized fruits of this variety have been popularly believed to be produced by perfect flowers. Yasui seems to agree with this point of view.

In this paper, the writers intend to describe the forms of pistillodes in their different degrees of development in staminate flowers, and also to investigate the habit and the mode of development of the staminode in the pistillate flowers in different varieties. Detailed study of the nature of the staminode in pistillate flowers in order to know whether it is functional as a male organ or not, is necessary not merely to throw light on the problem of sex, but also to elucidate the bearing of the pollinizer on kaki growing. For even in this tree, which bears parthenocarpic fruit rather freely, the effect of pollination on the quality and setting rate of the fruit is remarkable. The origin of the intermediate forms of the flower—whether they are derived from staminate flowers or from pistillate ones—will also be discussed.

## I. Material and Methods

The material used in these studies was obtained from trees in one of the experimental orchards of the Agricultural College, Kyoto Imperial University. All the trees were 6 years old after planting at the time of the investigation.

For the observations of the staminate flowers, four monoecious varieties, Egoshō, Goshō, Shogatsu and Zenjimarū were selected. The male flowers open in the early morning, anthesis soon follows and most of the flowers are shed by the evening of the same day. The flowers were picked every morning during the blooming season.

A well-grown cluster of staminate flowers consists of three flowers, namely one terminal and two lateral. One or two of the lateral flowers can often be lacking. These three types of clusters are indicated as three, two and single-flowered clusters, and the terminal flowers of these three clusters as  $t_1$ ,  $t_2$ , and  $s$  respectively; the lateral flower is



represented by *l* (Fig. 1). These three different types of clusters were seen mixed on a tree or even on a shoot in all the varieties examined, except Goshō, in which the most of the clusters were solitary.

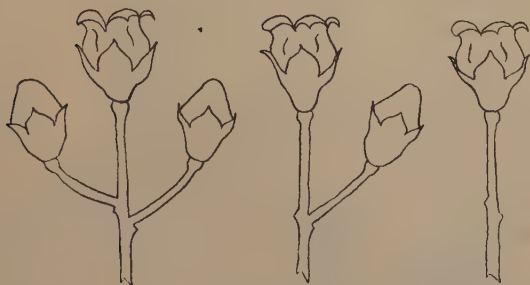


Fig. 1. Three types of staminate cluster. Three flowered, two flowered, and solitary clusters are presented. 1/1.



Fig. 2. Arrangement of scars of stamen on a receptacle (left) and the stamens in inner (middle) and outer whorls (right). 4/1.

The normal flower is tetramerous and the calyx is valvate; the four corolla lobes are spirally folded before opening. Sixteen or more stamens with short filaments originally occur in four cycles, apparently arranged in two whorls (Fig. 2). The stamens in the outer whorl are generally larger and the filaments more conspicuous than those in the inner whorl. The pistillode ceases to grow early and usually remains small. Often, a few flowers were found to be pentamerous.

After being collected, the fully bloomed flowers were at once placed in 70 % alcohol and preserved. If the observation seemed likely to be delayed, the alcohol was changed two or three times at intervals of one or two days to prevent the darkening of the material. At the observation, the perianth was removed and the stamens in the inner and outer whorls counted separately. The length and width of the pistillode were measured, and figures of them were sketched under a microscope with a camera lucida. In some varieties, sections of pistils and pistillodes were made according to the usual procedure of the paraffin method; they were stained with FLEMMING's triple staining, and certain histological differences in these two organs were compared.

The varieties used for the observation of pistillate flowers were as follows :

* Aizumishirazu	* Giombo	* Mikado
* Amahyakume	* Hagakushi	* Mompei
* Anzai	Hanagosho	Shogatsu
* Atago	* Hiratanenashi	* Shimpei
* Dojohachiya	* Ibogaki	* Tenjingosho
Egosho	* Inayama	* Tsukishiro
* Emon	* Jiro	* Yokono
* Fuji	* Kuramitsu	* Yotsumizo
* Fuyu	* Kyara	Zenjimaru

The asterisks indicate the apparently dioecious varieties bearing pistillate flowers only.

The flower buds of some varieties, such as Emon, Fuyu, Dojohachiya and Zenjimaru, were collected at intervals of three days from the 10th of May up to the blooming period and the other varieties were taken on the day before full bloom during the season of 1929. Before the fixing, preliminary tests by the iron-aceto-carmin method were made to determine the stage of development of the staminodes. However, on account of the rather rare occurrence of pollen mother cells in the staminode, most of these operations proved to be nearly to no purpose.

As the fixative, BRASIL's modification of BOUIN's fluid was used. According to NAMIKAWA and HIGASHI (14), this fluid is suitable for the killing of pollen mother cells of kaki. In their young stage, the staminodes together with the petal, to which they are attached, were dipped into the fixative, and in the later stage, namely, after the 27th of May, the staminodes were taken separately from the petal and then fixed. Cross and longitudinal sections were cut from 10 to 12  $\mu$  thick by the ordinary paraffin method and stained with HEIDENHAIN's iron-alum-haematoxylin.

## II. Results with the staminate flowers

### 1. *Zenjimaru*

All the staminate flowers of a tree were picked when they bloomed throughout the blooming season, which lasted a little more than two weeks from the 24th of May in 1929. From external appearance, two types of staminate flowers are distinguished. The one is generally larger in its outline, especially in its calyx lobes (Fig. 3, b). The size of the pistillode in most of the flowers of this type is greater than that of the usual staminate flowers. The other type is that of the

normal staminate flower (Fig. 3, c). The flowers in the different positions in the cluster were taken separately so as to distinguish the possible influence of the locality on the inflorescence. The number of stamens in a flower is variable, especially in the outer whorl. The variations in the number of stamens in the different whorls and in the total are presented in Tables I and II.

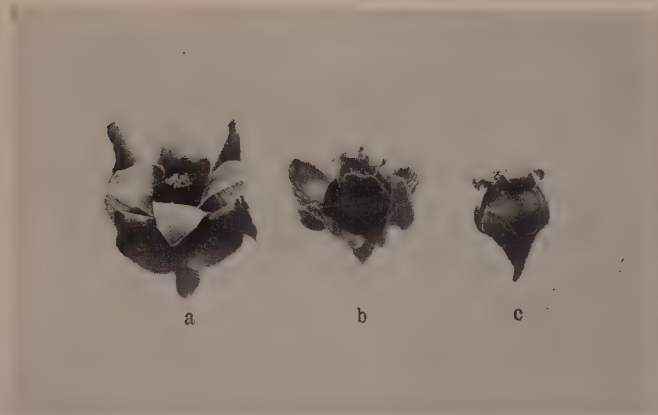


Fig. 3. Types of flowers in Zenjimarū. Pistillate, large staminate and normal staminate flowers are presented from left to right. 1/1.

TABLE I

Variation in the number of stamens in the outer and inner whorls in Zenjimarū.

	Number of stamens	7	8	9	10	11	12	13	14
Outer whorl	Terminal flower $t_1$		35	25	22	20	8	2	
	Terminal flower $t_2$		11	11	8	6	5		
	Lateral flower $l$		21	28	30	23	13	3	
	Solitary flower $s$		16	21	47	25	18	2	1
Inner whorl	Terminal flower $t_1$	1	84	15	6	2	2		
	Terminal flower $t_2$	1	25	11	3	1			
	Lateral flower $l$	1	70	27	16	4			
	Solitary flower $s$	2	51	39	25	10	2		

TABLE II

Total number of stamens in the staminate flowers of Zenjimarū.

	15	16	17	18	19	20	21	22	23	24	25
Terminal flower $t_1$		35	23	18	14	9	5	2	2	1	1
Terminal flower $t_2$	1	9	8	7	8	2	3	3			
Lateral flower $l$	1	20	17	27	15	21	8	5	3	1	
Solitary flower $s$	1	14	13	23	21	32	9	7	5	0	3

The total number of stamens in both solitary and lateral flowers is greater than that in the terminal flowers  $t_1$  and  $t_2$ . This increased number of stamens is due to variation in the number in the outer whorl, but not in the inner whorls, because the mode of variation of the inner whorls is the same in every type of flower and the maximum point in the variation curve is situated at 8.

The size of the pistillodes varies considerably, there being a continuous series of intermediate forms linking the entirely stunted and the well-developed specimens (Fig. 4). The length and width of the pistillodes are shown in Tables III and IV, each group of flowers being taken separately.



Fig. 4. Pistillodes in the staminate flowers of Zenjimarū. From entirely stunted to well-developed specimens are represented. 6/1.



TABLE III

The length of the pistillode in staminate flowers of Zenjimaruru.

mm.	0-1.0	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0
Terminal flower $t_1$	2	22	36	8	10	1	7	18	5
Terminal flower $t_2$	1	8	9	3	2	3	2	8	3
Lateral flower $l$	6	22	30	15	6	9	12	15	3
Solitary flower $s$	1	16	36	12	11	9	9	22	12

TABLE IV

The width of the pistillode at its basal portion in Zenjimaruru.

mm.	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4
Terminal flower $t_1$	1	13	26	20	12	7	4	8	3	4	7	2	1	1	1
Terminal flower $t_2$		4	10	4	4	4	4	0	1	4	4	0	1	1	
Lateral flower $l$	5	14	25	23	18	10	3	2	5	5	6	1	1		
Solitary flower $s$	2	3	22	17	16	9	13	10	7	12	7	5	3	2	

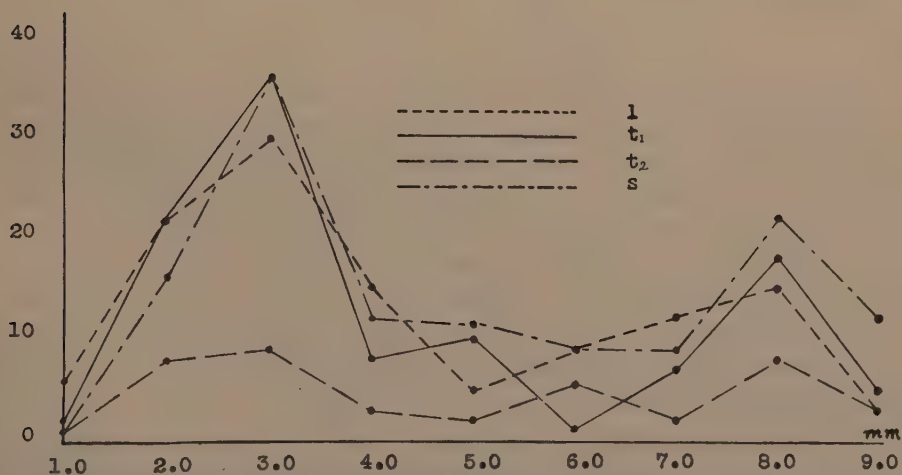


Fig. 5. Variation in the length of pistillodes from different flower groups in Zenjimaruru.

From the length of their pistillodes, two types of staminate flowers were distinguished as is shown in the two-maximum curves given in Fig. 5. Two maximum points of length coincided in the four groups classified according to the position on the inflorescence.

Besides the variation visible to a certain extent in the development of the pistillode in the flowers in the same position in the clusters, many differences in the degree of development were noted in the flower groups from different positions in the clusters. The ratio of the number of flowers with large pistillodes (5.1–9.0 mm. long) and of those with small pistillodes (1.0–5.0 mm. long) differs in different flower groups, as is shown in Table V.

TABLE V

The proportion of the flowers with large and small pistillode  
in the four flower groups of Zenjimarū.

mm.	1.0–5.0	5.1–9.0	Ratio $\left(\frac{\text{large}}{\text{small}}\right)$
Terminal flower $t_1$	78	31	0.39
Terminal flower $t_2$	23	16	0.69
Lateral flower $l$	79	39	0.49
Solitary flower $s$	76	52	0.68

The proportion of flowers with large pistillodes was greater in the  $t_2$  and  $s$  than in the other two ( $t_1$  and  $l$ ) flower groups. This relationship denotes that the development of the floral organ is influenced by its location in the cluster and also by the number of the flowers in the cluster, probably due to the nutritional or spatial conditions or both. The width of the pistillode was generally correlated with the length of it. In the variation curve of the width, however, such a dimorphic feature as was seen in the length was not evident. Also in this case the first maximum point in the width precisely coincided in the different groups of flowers (Fig. 6).

A somewhat disfigured ovule was often formed in certain pistillodes, and the size of it in well-developed pistillodes was scarcely inferior to that of a normal pistil (Fig. 7). The embryo sac was also developed in certain ovules.

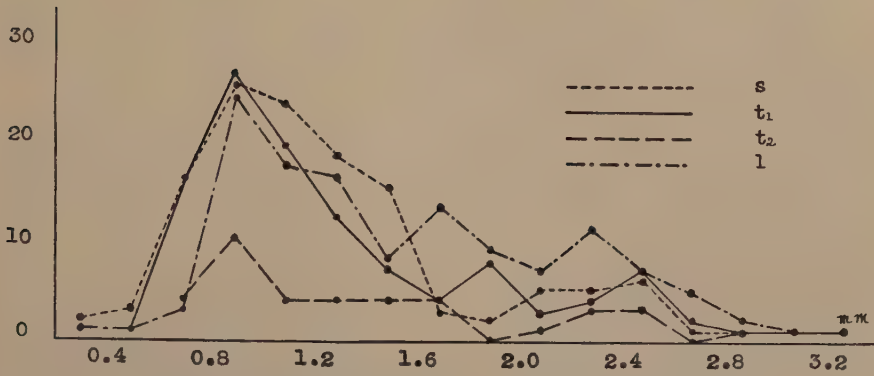


Fig. 6. Variation in the width of pistillodes of Zenjimaruru.



Fig. 7. Ovarian cavity in a stunted pistillode (a), ovules of well-developed pistillodes (b-d) and of pistils (e, f). 12/1.

In the fruit of kaki, a well marked stone-cell layer was found developed in hypodermal layers of the pericarp. The stone-cells were beginning to differentiate by the blooming time in the upper part of the ovary in the pistillate flowers. The cells were marked larger than the adjacent cells and a large vacuole was visible in each cell. The nucleus of the cell was roundish and as much as twice the diameter of those of the neighbouring cells (Fig. 8, a). Such initiation of the stone-cells was not yet evident in the middle and basal parts of the ovary in this

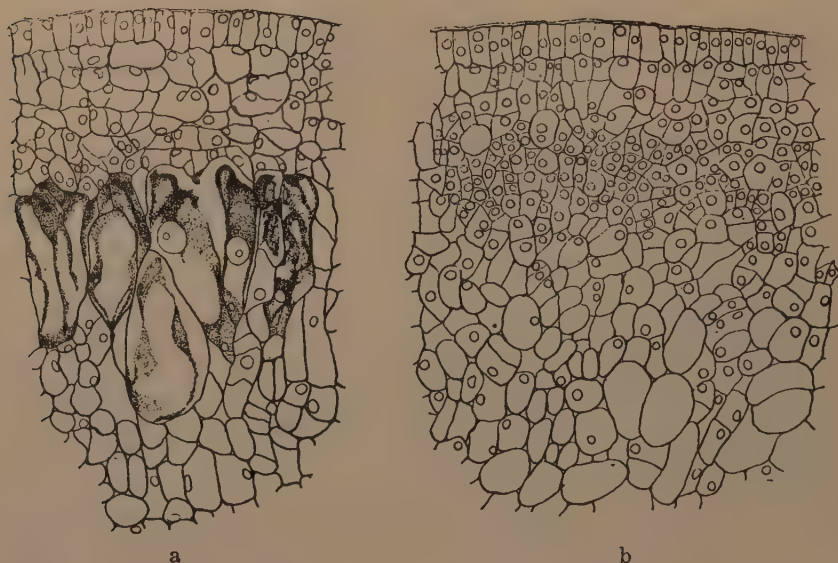


Fig. 8. Longitudinal sections through the ovary in a pistillate flower of Zenjimar. a: Upper part of the ovary. The stone-cell layer is initiating in the hypodermal layer. b: Basal part of the pistil. The differentiation of stone-cells is not evident and the hypodermal layer remains in meristematic conditions. 240/1.

stage, and the layers in which the stone-cells would afterwards be differentiated remained in the meristematic condition, the cells being small and isodiametric with dense plasmatic contents (Fig. 8, b). Thus the development of the tissue proceeds in the basipetal direction. In the ovaries of staminate flowers, on the other hand, the development throughout the corresponding tissue was further advanced. Each cell was generally bulky, poorer in plasmatic contents than in the case of pistillate flowers, and its nucleus was somewhat flattened in shape.



However, the initiation of the stone-cell layer could not be seen in this case (Fig. 9).

Under certain favourable conditions, the larger type of pistillode develops to a fruit. It is generally distinguished by its oblong shape and small size from the normal fruit. One of the specimens obtained in the experimental orchard on the 31st of August, 1931, is shown in Fig. 10. The fruit contained three seeds, each of which was a little smaller in size than the normal seed but much plumper and somewhat

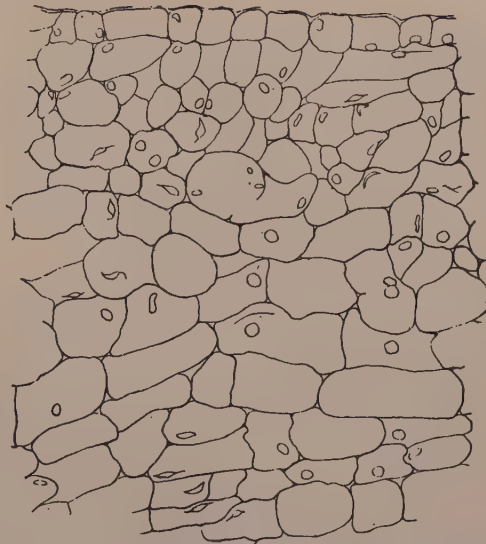


Fig. 9. Longitudinal section through the upper part of the pistillode. No sign of the differentiation of stone-cells is visible. 240/1.

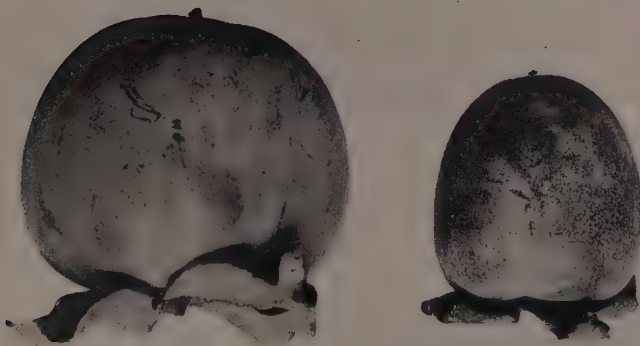


Fig. 10. Two types of fruit in Zenjimar, the normal (left) and the oblong (right). The latter set on a male cluster. 1/1.



different from other varieties, in which the number of stamens is much more variable in the outer whorl than the inner. The maximum point in both variation curves of the number of stamens in the inner and outer whorls lay at 10 instead of the standard number 8. This feature, evident in male flowers, also agrees with the fact that the fruit of Gosho has been popularly said to show often pentamerous structure. The length of the stamens in the inner whorls, however, was markedly less than that of the stamens in the outer whorls (Fig. 12).

The total number of stamens ranged from 15 to 29 and the peak was situated at 20 (Table VII).

With regard to the stamens in the outer whorl, besides the pleiomery indicated by the number, petaloidal changes were found to have taken place to a certain extent in some flowers (Fig. 12).



Fig. 12. Stamens and petalodes in Gosho. The upper row represents the petalodes, the middle the stamens in outer whorl, and the lower the smaller stamens in inner whorl. 9/10.

TABLE VII

Variation in the total number of stamens in the staminate flowers  
in different varieties.

Variety	Flowers	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Gosho	Solitary		3	10	7	15	11	17	12	12	9	9	3	1	0	1	1
Egosho (133)	Mixed				2	3	5	4	3	2	3	3	2	1	0	1	
Egosho (134)	Terminal				2	4	4	1	3	6	1	2	0	1	0	1	
	Lateral			12	8	8	8	8	2	0	1	1					
Shogatsu	Terminal		1	51	4	4											
	Lateral	1	5	32													

The variation in the size of the pistillodes in Gosho was also considerable, but the variation curve manifested only one maximum point,

differing from that mentioned in the previous variety. It is noticeable that even in relatively well-developed pistillodes, the style was generally stunted. The length of the pistillodes fluctuated from 0.6 mm. to 9.5 mm., the maximum point being situated at 2.1–3.0 mm. (Table VIII), while in width they ranged from 0.6 mm. to 7.0 mm. and were much wider than those of Zenjimaru. The maximum point was at 1.1–2.0 mm. (Table IX).

TABLE VIII

The variation in the length (mm.) of the pistillode in the staminate flowers in different varieties.

Variety	Flowers	0.1– 1.0	1.1– 2.0	2.1– 3.0	3.1– 4.0	4.1– 5.0	5.1– 6.0	6.1– 7.0	7.1– 8.0	8.1– 9.0	9.1– 10.0
Gosho	Solitary	1	33	69	7	5	2	0	2	1	1
Egosho (133)	Mixed	2	3	8	10	4	1	0	0	2	
Egosho (134)	Terminal		12	8	3	1					
	Lateral		25	11	1	1					
Shogatsu	Terminal			29	31						
	Lateral	1	6	21	9						

### 3. *Egosho* (Tree number 133)

Flowers were taken on the 21st, 23rd, 24th and 25th of May, 1930. The number of stamens in a flower was variable in this case also, but within rather narrower limits than those of the former varieties. The increase in number was more marked in the outer whorl than in the inner. The range was from 9 to 15 in the outer and 7 to 13 in the inner whorl. The maximum point of the variation in the number in the outer and inner whorls was situated at 11 and 9 respectively (Table VI).

The size of the pistillodes varied very widely, and only one maximum point was present in the variation curve. Their length varied from 0.6 mm. to 9.0 mm. and its maximum lay at 3.1–4.0 mm. (Table VIII). The width fluctuated from 1.1 mm. to 7.0 mm. and its maximum lay at 1.1–2.0 mm. (Table IX).



TABLE IX

The variation in the width (mm.) of the pistillode in the staminate flowers in different varieties.

Variety	Flowers	0.1-1.0	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0
Gosho	Solitary	7	75	19	5	4	0	1
Egosho (133)	Mixed		12	8	6	2	1	1
Egosho (134)	Terminal		17	5	1	1	1	
	Lateral	3	45					
Shogatsu	Terminal		58	2				
	Lateral	3	35					

#### 4. *Egosho* (Tree number 134)

Flowers were picked from the tree on the 25th of May, 1930. According to their position in the clusters, the flowers were separated into two groups, terminal and lateral. The variation in the number of stamens in the terminal flowers differed markedly from that in the lateral flowers. The maximum of the variation in the total number was situated at 22 in the terminal, and at 16 in the lateral (Table VII). In the terminal flowers the maximum of both the outer and inner whorls was situated at 10, while in the lateral it was 8 (Table VI).

In the length of the pistillode the terminal and lateral flowers exhibited no marked difference. The range in both groups was from 1.1 to 5.0 mm. and their maxima lay between 1.1 and 2.0 mm. (Table VIII). But the pistillodes were much wider in terminal flowers than in lateral, viz. the width ranged from 1.1 to 6.0 mm. in the terminal and from 0.1 to 2.0 mm. in the lateral, even though both their maxima lay at 1.1-2.0 mm. (Table IX).

In the number of stamens and the size of the pistillodes, the variations in the terminal flowers of this tree (No. 134) closely resem-

bled those in the former tree (No. 133), but the numerical values connected with lateral flowers were much smaller than those of the terminal flowers on this tree as well as than those of tree 133, especially in the case of the total number of stamens and the width of the pistillodes.

#### 5. *Shogatsu*

Flowers were collected from the tree on the 21st, 22nd, and 24th, of May, 1930. The number of stamens and the size of the pistillodes varied least in this variety. The number of stamens was generally 8, agreeing with the fundamental number of stamens in kaki flowers. No differences could be found between the outer and inner whorls or between the terminal and lateral flowers, in this variety (Tables VI and VII).

The range in the length of pistillodes in the terminal flowers was between 2.1 mm. and 4.0 mm. and in lateral flowers between 0.1 mm. and 4.0 mm. The maxima in the terminal flowers lay at 3.1–4.0 and in the lateral flowers at 2.1–3.0 mm. (Table VIII). The width of the pistillodes was rather uniform and ranged from 1.1 mm. to 2.0 mm. in both terminal and lateral flowers (Table IX).

#### 6. Intermediate flowers due to deformation

Gosho and Egosho often bore some deformed flowers, nearly as large as pistillate flowers in their size, and not unlike the staminate flowers in their external appearance. Generally in kaki flowers, the staminate flowers drop after anthesis from the base of the receptacle, but pistillate flowers shed only the corolla together with the staminodes attached to the inside of it. These deformed flowers were not shed even after their anthesis. Moreover one half side of the corolla was separated from the base. Inside this part of the corolla a few staminodes are attached firmly, while normal stamens were attached to the base of the other half of the corolla. These unusual flowers revealed the male character on one side of the flower and the female on the other. Some of these flowers in Gosho continued their development for two or three weeks and in Egosho remained unshed for a month or more after blooming. The pistillodes in these flowers were well developed (Fig. 13). In some of them, the size of the pistillodes was not inferior to that of the normal pistil in the pistillate flower. The length and width of the pistil was 11.0 mm. and 8.0 mm. in Gosho and Egosho respectively, while the pistillodes were 9.0–10.0 mm. in length and 7.0–8.0 mm. in width (Tables X and XI). The total number of stamens

in these flowers in Gosho was 13, arranged mostly in a whorl (Table X). In Egosho, the total number of stamens varied from 8 to 31, and besides these normal stamens there were 2-7 staminodes (Table XI).



Fig. 13. Deformed intersexual flowers of Egosho. These flowers express the female character on one side and the male on the other. Two well-developed pistillodes, 4 stamens (a) and 6 staminodes (b) were given. 9/10.



Fig. 14. The ovule in an intersexual flower represented in Fig. 13. 12/1.

TABLE X

The number of stamens and the size of the pistillodes in the disfigured intermediate flowers and the size of the pistil in the pistillate flowers in Gosho.

	Number of stamens				Size of pistillodes and a pistil (mm.)	
		Outer whorl	Inner whorl	Total	Length	Width
Intermediate flower	a	12	1*	13	9.2	8.0
	b	10	3	13	9.5	7.0
Pistillate flower		—	—	—	11.0	8.0

\* A staminode.

TABLE XI

The number of stamens and staminodes, and the size of the pistillodes of intermediate flowers in Egosho.

Flower	Number of stamens			Number of staminodes			Size of pistillodes (mm.)	
	Outer whorl	Inner whorl	Total	Outer whorl	Inner whorl	Total	Length	Width
a	10	6	16	5	1	6	5.4*	4.4
b	13	18	31	0	0	0	4.0*	2.7
c	10	2	12	2	1	3	10.0	8.0
d	7	1	8	7	0	7	9.2	7.0
e	9	9	18	3	3	6	9.0	6.4
f	10	1	11	2	0	2	10.0	7.5

\* Styles have been stunted.

It is interesting to note that in Egosho these deformed flowers were only found in the terminal position in the cluster and never in the lateral. The size of the ovule in these large flowers was not inferior to that of pistillate flowers. The relation between them will be seen by comparing Fig. 13 with Fig. 7, e-f. The embryo sac was also well developed. The stone-cell layer was differentiated throughout the outer wall of the carpel at the time of anthesis, while in the normal pistil in the pistillate flower the development of this layer was localized at the top region of the ovary, and it did not extend to the basal part of it. Just as in the case of Zenjimarū, the initiation of the stone-cell layer could not be seen in the pistillode.

### III. Results with the pistillate flowers

The number of the staminodes in a pistillate flower was normally eight, arranged in two whorls. The outer whorl is provided with four antipetalous staminodes and the inner four parapelalous. As a rule, the antipetalous staminodes were slightly larger than the parapelalous ones. Deviation from the number eight was occasionally seen. The staminode was under-sized as compared with the stamen in a staminate flower, and there were slight differences in size among the



varieties. In the varieties Emon, Fuji, Inayama, etc. the staminode was generally large, and in Dojohachiya, Fuyu, Zenjimaruru, etc., it was small. No conspicuous deformities in the shape of the staminode were noticed.

Examination of the internal structure of the staminodes showed that no specialized tissue was developed in some of the varieties. The periphery of the anther was covered with one layer of epidermis and the inner portion was occupied by ordinary parenchymatous tissue (Fig. 15). The staminode of Anzai, Dojohachiya, Fuyu, Hagakushi, Ibogaki, Kuramitsu, Tenjingosho and Yotsumizo, was of such a structure.

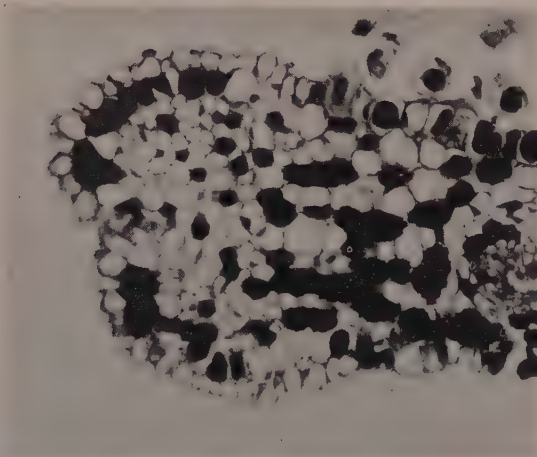


Fig. 15. A cross section through an anther of the staminode in Fuyu, not any specialized tissue being developed in it. 100/1.

In many other varieties, however, the inner structure in some of the staminodes was a little differentiated. In the latter part of May, certain signs of degeneration were observed at the loculi in the anther. If a notation is used for the loculi in the cross section of the anther, as represented in Fig. 16, in the great majority of cases, the degenerations occurred at I-II, much less often at I-II-IV or I-II-III and rarely at I, II or I-II-III-IV. At this time, degeneration took place also in the bordering parenchyma between the outer and inner loculi and the resulting figure was seen as a slit of the disorganised tissue (Fig. 17). Cavities were formed as a result of disorganisation of the tissue in some staminodes. The cavity occurred just at the microsporangial

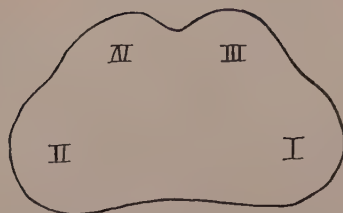


Fig. 16. Diagram indicating the position of loculi with number in cross section of an anther.

region of an anther. The number of cavities in one cross section was mostly three, and sometimes four, two or one.

In the earlier stage of degeneration, the plasmatic contents of the tissue disappeared and only disorganized membranes were visible in the cavity. At the blooming period, the cavity became entirely empty. No distinct sporogenous cells could be found before the degeneration. The parenchyma between the

outer and inner loculi also continued to degenerate. Eventually, the two cavities were connected with each other (Fig. 18). The cavity thus formed was surrounded by one or two middle layers and a layer of epidermis. The depth of the cavity was rarely above a half of the full length of the anther, but generally from  $1/8$  to  $1/4$  of it.

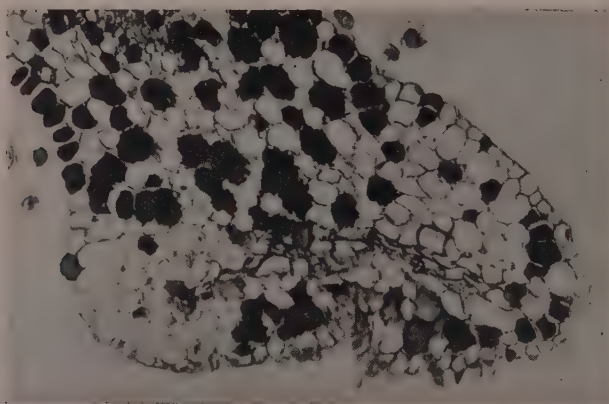


Fig. 17. Cross section through an anther of Mikado, showing the shrunken tissue in it. 180/1,

Besides, in a few of these varieties, the sporogenous cells in their development occurred at the normal microsporangial regions of the staminodes. The number of the microsporangia with these sporogenous cells appearing in a cross section was generally two and less frequently one or three (Fig. 19). In Inayama flowers, taken on the 15th of May, it was found that the archesporial division had finished, and as shown in Fig. 20 four or five pollen mother cells were located within a tapetal layer. When it was young, the pollen mother cell was

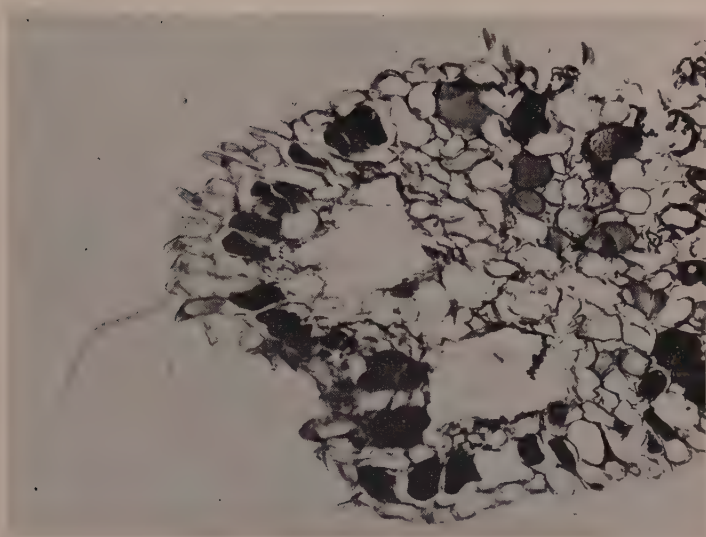


Fig. 18. A cross section through a staminode of Egosho taken at the blooming time. A figure of the degeneration is noticed in parenchyma between outer and inner cavities. 180/1.

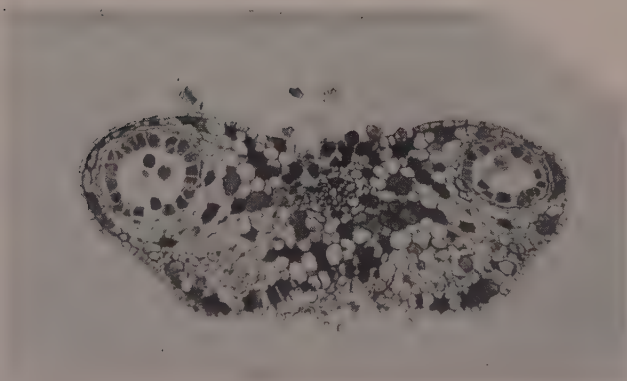


Fig. 19. An anther of staminode of Fuji. Pollen mother cells occurring in two loculi of it. 100/1.

polyhedral in shape, densely filled with cytoplasm and had a large nucleus. Each of the tapetal cells was provided in general with a single nucleus, and sometimes with two. The number of the pollen mother cells visible

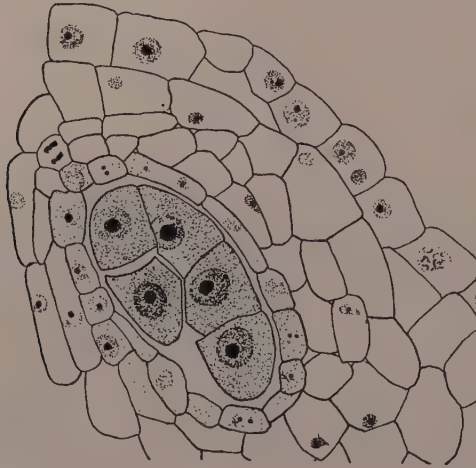


Fig. 20. Pollen mother cells in a young staminode of Inayama. 260/1.

in a cross section was from three to five. Not all the stages of the meiosis of the pollen mother cells could be traced, but a few stages were observed. The pollen mother cells in the staminodes of Inayama fixed on May 24 were at the stage of early diakinesis. The staminodes from different flowers of Fuji obtained on May 31 revealed the stages of leptoneuma, synzesis, diakinesis, I-metaphase, interkinesis and II-metaphase. All of these figures seemed to be normal. The pollen mother cells in the different microsporangia in the same anther were not at the same stage of the development. Even in one pollen sac, the stages of the different pollen mother cells were not uniform. In certain cases, the various stages from diakinesis to homotypic metaphase were observed in a single longitudinal section of Fuji.

The tetrad stage was often seen (Fig. 21). In the later tetrad stage, some tetrads of Fuji, which had degenerated before their liberation from the tetrad, were observed. The degenerated tetrads were richly vacuolated and stained deeply with haematoxylin (Fig. 22). Except these, all the other tetrads gradually grew and were liberated completely.



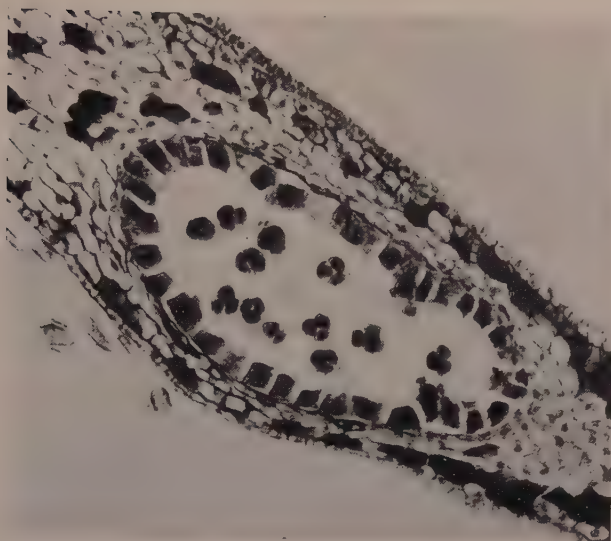


Fig. 21.. Tetrads in an oblique section through a staminode of Fuji., 150/1 ,

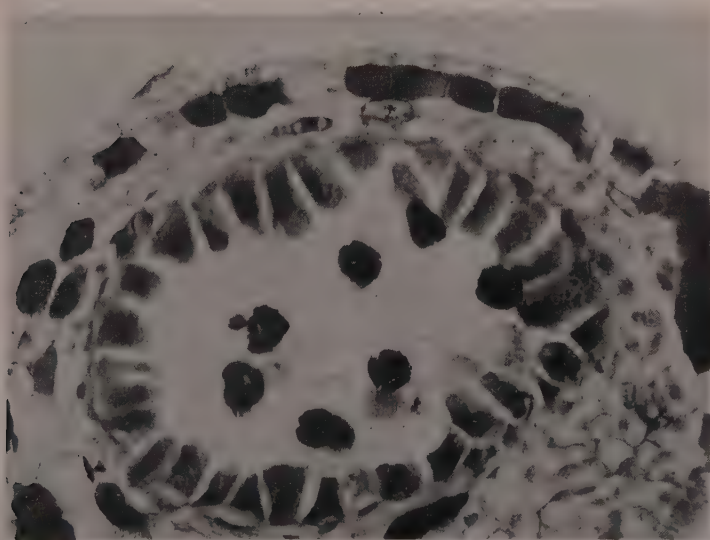


Fig. 22.. Degenerated tetrads in a staminode of Fuji. 260/1 .

Thus, the pollen grains were partially produced. They were normal in their appearance, spherical in general outline but slightly angular and furrowed (Fig. 23). There were no conspicuous differences in size among the observed pollen grains. It was found, however, that the pollen grain of Fuji was somewhat smaller than the others. The size of the pollen grain, in the normal stamen as well as in the staminode in general, was within the range of 30–40  $\mu$  in diameter. In a few loculi of Fuji, the pollen grains were all withered. The number

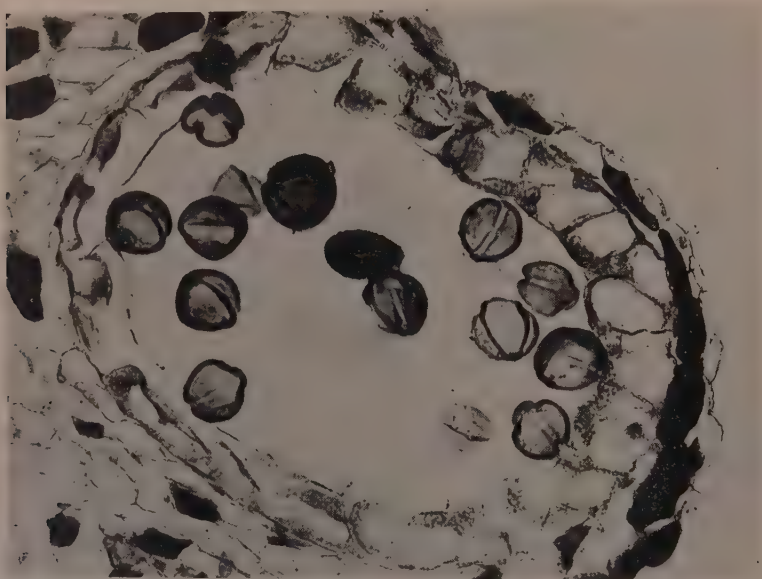


Fig. 23. Cross section through a microsporangium of staminode of Inayama, apparently normal pollen grains being produced in it. 260/1.

of the pollen grains appearing in a cross-section of an anther, was from three to fifteen or sometimes even more. Ordinarily the tapetal cells still persisted at this time, though some of them were beginning to disintegrate. Such a pollen was observed in the staminodes of four varieties, Fuji, Hanagoshō, Inayama and Mompei. The number of the staminodes in which the pollen grains were formed was rather small. For comparison, the total number of the staminodes examined in these four varieties and the frequency of the sporogenous cells that occurred are shown in the following table.

TABLE XII

The frequency of the occurrence of sporogenous cells in the staminode in different varieties.

Variety	Date of fixing	Total number of staminodes observed	Number of staminodes with sporogenous cells.
Fuji	May 31	40	10
Fuji	June 5	40	8
Hanagosho	May 31	50	5
Hanagosho	June 5	24	0
Inayama	May 15	48	4
Inayama	May 24	40	2
Inayama	May 27	55	7
Mompei	June 4	50	2

The occurrence of the cavities in the anther in which sporogenous cells were not seen was much more frequent in these four varieties. And even in these varieties, there were some staminodes in which the development of any specialized tissue was never observed.

To ascertain whether the seed could be brought about by the selfing of such pollen or not, the pistillate flowers in some of these varieties were covered with bags. In Fuji, fifty pistillate flowers thus bagged produced none. In Inayama, one fruit resulted out of fifty pistillate flowers bagged, but parthenocarpically. In the case of Hanagosho, seventeen fruits were obtained out of one hundred pistillate flowers treated, and after careful examination of these fruits no sign of seed development could be found. It was recognized later that the anther did not dehisce and the pollen was not shed naturally even at the time of blooming. The pollen grains were taken out artificially from these anthers and the germination test was made. The media contained 1% of agar-agar with 3/10 M sucrose, and their pH-value was 5.5.\* The result was that the pollen entirely failed to germinate, and the pollen did not seem to be viable.

\* In our experience with the pollen of kaki, a medium of this composition is the most suitable for artificial germination.

#### IV. Conclusion

Hermaphrodite flowers are not produced regularly on kaki trees. An intermediate or weakly hermaphroditic form is observed occasionally. This is to be interpreted as meaning that this intermediate form is transformed either from pistillate or from staminate flowers. For the purpose of settling this question, the staminodes in pistillate flowers and the pistillodes in staminate flowers have been investigated. In the first place, the results obtained with the staminodes in pistillate flowers will be scrutinized.

As to the size of the staminodes in strawberries, VALLEAU (26) demonstrated a wide range of deviation in some pistillate plants. Investigating the development of stunted stamens, FAMILLER (6) found that, in various plants, the development of certain staminodes was restrained in their primordial stage and in size and structure they were not unlike the filament of the other well developed staminodes occurring in the same flower. Recently ROHRHOFFER (19) noted in the species of *Bignoniaceae* that the degree of development of the staminodes in certain species could be diverse. Such irregularity as is seen in other plants is not found in the present material and there are no staminodes of which the development has been interrupted at the primordial stage. Their external appearance indicates that they are in a slightly stunted condition.

Considering the nature of the loculi which often occurred in the anther of the staminode, they must have been originated by a disorganisation of certain tissue. Judging from the location of the loculi in the staminode, the number of them in a cross section and the direction in which degeneration extends, the tissue subjected to degeneration is closely related to the sporogenous cells.

Differentiation of pollen mother cells takes place in some staminodes of the kaki, as has been reported in connexion with the staminodes of different plants. Though the stages of development of the pollen mother cells are not always the same even in a microsporangium, their development proceeds normally to the tetrad. It is reported by several authors, such as ASAMI (1), OSAWA (16,17), SHOJI and NAKAMURA (24), VALLEAU (26) and others that in many sterile plants the development of the pollen mother cells often passes normally into the tetrad stage. Except for some degenerated figures of the tetrad observed in Fuji, the tetrad or tetraspores in the staminode, if there are any, are normal.



No evident irregularity in the meiotic division is taking place in this case.

FAMILLER (6) reported that the pollen grains were formed in reduced stamens or staminodes in different plants. In his study of the staminodes, SCHWARZE (23) observed that a stamen which remained a staminode in ordinary circumstances, could often be established in the normal size and shape, and became functional. In the case of *Asparagus officinalis*, however, SHOJI and NAKAMURA (24) reported that the pollen mother cells which had been formed in the staminode of the pistillate flower were entirely disorganized not developing to pollen grains.

According to the degree of development up to the flowering period, the staminodes of kaki are classified into three groups as follows :

1. The sporogenous cells are not differentiated.
2. The lysigenous cavity is formed.
3. The sporogenous cells are formed and develop to the tetrad stage.
  - a. Degeneration takes place at the time of liberation of the tetrad.
  - b. Apparent pollen grains are produced.

What seems to be pollen is occasionally formed in some staminodes of certain varieties, such as Fuji, Hanagoshō, Inayama, and Mompei. However, the anther never dehisces, and natural pollination does not seem to be secured with such pollen. The pollen grains were taken out artificially from the anther and the germination test was made under suitable conditions and they were proved to be inviable. These flowers can not be called hermaphroditic, and the production of pollen of this sort is really of no significance from the standpoint of fruit-growing.

NYI (15) described the sex differentiation in *Firmiana simplex*. In this monoecious plant, the intermediate forms may be occasionally formed in a staminate panicle as well as in a pistillate one. The male panicle was found to bloom earlier than the female and the development of the intermediate forms was always contemporaneous with that of the pistillate flowers. This case somewhat differs from our present material. The general character of the intermediate forms observed during the present work is more akin to staminate flowers than to pistillate ones. It is reasonable to suppose that the intermediate flower is a modified form of the staminate flower. CORRENS (4) pointed out

that the occurrence of hermaphroditic flowers in *Silene Roemerii* was a result of the sudden development of pistils in the staminate flower so that they became functional, but was never due to the development of stamens in the pistillate flower. Also SHOJI and NAKAMURA (24) observed that a staminate individual of garden asparagus bore a type of pistillode in different flowers. Among numerous individuals, a series of the pistillode type could be found with continuous links showing transition forms from the entirely styleless to nearly full-developed specimens. It was remarkable that berries were produced in some male individuals of garden asparagus (11,24). The process of transformation from staminate to intermediate or weakly hermaphroditic flower in kaki may be similar to the cases just mentioned, though the statements quoted were made with regard to polygamous or dioecious plants.

The investigation of the pistillodes in staminate flowers results in the classification of the monoecious varieties of kaki into three types, according to the degree of development of the pistillodes. The first evinces a considerable variation in the size of the pistillode and these male flowers can be divided from their external appearance into large and small flower groups. In the curve representing the variation in the size of the pistillodes two maximum points are manifest. In this case, the larger flowers seem to develop so far as to be of hermaphroditic nature. Thus the flowering habit of this kind is trimonoecious (5). A representative variety of this type is Zenjimaruru. In the second type, the size of the pistillode is also variable: the variations give, however, a one-maximum curve. Varieties of this type do not produce the hermaphroditic forms. Egosho and Gosho belong to this type. The third bears staminate flowers with pistillodes of uniform size. No intermediate flowers are produced. Shogatsu is an example of this type.

Several statements have been made with regard to the factors by which the sexual transformations were brought about in different plants. CORRENS (3,5) reported several cases in which the sexuality was predetermined by the genetic constitution. ROSA (20) stated in his paper on spinach, that two types of male plants were produced owing to genetic factors, and not to environmental influences. LEVITSKY (10) concluded that the form and size of rudimentary pistils in asparagus were determined genetically for the most part and also influenced by external conditions in part. On the other hand, numerous instances of the physiological control of the sex in plants

have been reported, with the suggestion that the various nutritive conditions, such as the fertility or moisture content of the soil, length of daylight, position of flower inserted, etc., were directly related to the sex expression. KÔRIBA (9,10) also is of opinion that various degrees of abortion in the sexual organ, can be brought about by two different conditions, namely, (a) by a certain stimulant or inhibiting substance occurring in the plant itself, and (b) by a spacing too limited for the development of the organ concerned at the primordial stage. MAEKAWA (12,13), SCHAFFNER (21,22) in *Arisaema* and hemp and others (18,27) in different plants, proved that certain sexual transmutations or sex ratios could be controlled by environmental or nutritive conditions experimentally. CORRINS (4) stated that in the case of *Silene Roemerii* the hermaphroditic flower required more nutriment than the staminate flower, and, when nutrition was poor, fewer hermaphroditic flowers were produced. GARDNER (7) also concluded that the female character in plants was associated with rich soils, abundant moisture, liberal spacing, the vigour of youth, and favourable growth conditions in general, while the male character was associated with less favourable growth conditions. SMITH (25) in his work on the eggplant concluded that the stunted style growth of the small pediceled flowers was directly related to the small area of the phloem of the pedicels. It was highly probable, he thought, that the limited function of these restricted channels for the transference of organic nutrients had an effect upon the growth of the styles. He stated further that, whatever the limiting factor might be, it appeared to inhibit greatly the development of the female organs but to alter the male organs only slightly.

The monoecious and trimonoecious (5) flowering habits are distinguished in the varieties producing staminate flowers. With regard to the occurrence of the intermediate forms in Zenjimarû, it is conceivable in the first place, that the initial of the male flower is differentiated in larger size than usual, and in the second, that some of the ovules in the under-sized pistil undergo certain changes that enable them to continue further development, probably due to favourable nutritive conditions or to ample space given to the primordial flower at the time of initiation. Some of these flowers develop to a fruit, though the size of it is always smaller than the usual. Also the seed in it is slightly disfigured.

The size of the ovule of the well-developed pistillode is not inferior to that of the normal pistil, and an embryo sac may often be detected



in it. Still a marked difference is discernible between the normal pistil in the pistillate flower and the full-sized pistillode in the intermediate one. The stone-cell layer is obviously differentiated in the ovary wall in the normal pistil at the blooming time but in the pistillode no sign of its differentiation can be observed.

The formation of intermediate flowers seems to be much influenced by the position of their insertion in the cluster and by the number of coexistent flowers on the same cluster. In fact, in the development of the flower bud, the bract is first differentiated, then the calyx, the petals, the stamens and finally the pistil. Hence, so far as the staminate flower are concerned, the conditions seem to influence more strictly the formation of the pistil. Actually, the terminal flower on a two-flowered or solitary cluster expands to the intermediate forms much more frequently than the terminal one in the three-flowered cluster or the lateral ones. It may be given a better chance for further development than the flowers in less favourable positions.

Another case of the intermediate form is brought about by a deformation in which certain terminal flowers in male clusters become larger in size and acquire the male character in one part and the female in another part of the flower. Its pistillode develops nearly as perfectly as the normal pistil of the pistillate flower. A similar phenomenon has been noticed in the strawberry flower (9, 26).

A few notes about evolutionary tendency in connexion with monoecism and dioecism may be added here. Generally speaking, in the higher plants, the dioecious form seems to be the most differentiated and most highly evolved form, and the monoecious is less highly evolved and the hermaphrodite form the least (3, 5, 28). So far as the case of *Diospyros* is concerned, however, the monoecious form is not always a higher form than the dioecious. If the relation of polyploidy as indicated in Table XIII is kept in mind, it will be understood that the tendency can, at least in the case of kaki, be reversed. If fifteen is the fundamental chromosome number in the species of *Diospyros*, *D. Lotus* and *D. discolor* are diploid forms and *D. Kaki* and *D. virginiana* hexaploids. Although it is not yet known how such hexaploid forms have been developed in the present genus, it is legitimate to surmise that the hexaploid form was evolved from certain diploid forms. The monoecious forms of kaki are not in the least less evolved than the dioecious. As was stated by HIERN (8), there is a gradient from the dioecious to the hermaphroditic form in this family. He stated that the flower in the great majority of species is dioecious,



but with an occasional tendency to a polygamous condition, and in the genus *Royeva* it is chiefly hermaphrodite. It is very important that further studies on the chromosome relation in this family should be made. As to the varieties of kaki which produce only pistillate flowers under cultivation, there is not enough evidence to prove their constitutional sexuality.

TABLE XIII

The relation of polyploidy in the different species of *Diospyros* (1).

Species	n	2n	Sexuality
<i>Diospyros Kaki</i>	45	90	Monoecious
<i>D. virginiana</i>	—	90	Dioecious
<i>D. Lotus</i>	15	30	Dioecious
<i>D. discolor</i>	—	30	Dioecious ?

## V. Summary

1) The morphological nature of the pistillate and the staminate flowers of kaki was investigated.

2) The number of stamens and the size of the pistillodes in the flowers of one variety and of different varieties were compared. The number of stamens exhibited a rather wide variation in most of the varieties examined. Shogatsu was the only variety in which the number of stamens was near to the standard number 16. Generally the variation was greater in the outer whorl than in the inner, though in Goshō the relation was reversed.

3) Three types of pistillodes could be classified as follows:  
a) Those in which the variation curve of their size presented two maxima. b) Those in which the variation showed a binomial distribution. c) Those in which the fluctuation in size was very small. In type a, the small pistillode was styleless, though in larger ones the style developed to nearly the usual size of the pistil in the female flower. The style of the pistillodes in type b was stunted.

(1) The chromosome number in *D. Kaki* and *D. Lotus* has been reported by NAMIKAWA and HIGASHI (14). Counts in the other two species were made with root tips by the same authors in this laboratory. Seed of *D. virginiana* and *D. discolor* were obtained by the courtesy of Mr. P. H. DORSETT, United States Department of Agriculture, and of Mr. I. SUZUTA, Central Research Institute, Formosa, respectively.

4) Flowers intermediate between the staminate and the pistillate are often produced in Gosho and Egosho by deformation. In general appearance they are not unlike male flowers, and one half side of each flower bears normal stamens and the other side staminodes. The pistil appeared to be normal. Usually, however, these flowers were shed 2-4 weeks after blooming.

5) The larger flowers in type a can result in certain deformed fruit under favourable circumstances. It is actually known that in the case of Zenjimaruru an under-sized fruit is often produced at the terminal of a male cluster. A brief description of such a fruit is given. The flowers of hermaphroditic nature are derived from staminate flowers.

6) No marked variation in the size of the staminodes was found, and there were no staminodes of which the development had stopped at the primordial stage.

7) The cavities in the anther of the staminode are formed by the disorganisation of certain tissue. It can be affirmed that the tissue subjected to degeneration is closely related to the sporogenous cells, judging from the location of the cavities in the staminode, the number of them in a cross section, the direction in which the degeneration proceeds, etc.

8) The pollen mother cells are often differentiated. Though the stages of their development were not always the same even in a locule, their development proceeded normally to the tetrad.

9) According to the degree of development up to the flowering period, the staminodes were classified into three groups as follows: 1. Those in which the sporogenous cells were not initiated. 2. Those in which the lysigenous cavity was formed. 3. Those in which pollen mother cells were formed and the meiosis proceeded in them up to the tetrad stage. The last group could be subdivided into two. a. Those in which degeneration took place at the time of liberation of the tetrad. b. Those in which apparent pollen grains were produced.

10) Though the apparently normal pollen grains were produced in four varieties, Fuji, Hanagosho, Inayama, and Mompei, the anther did not dehisce even at the blooming time. The pollen was taken out artificially from the anther and a germination test was made with it, and it was proved not to be viable.

11) No hermaphroditic flowers developed from the pistillate type.

---

## LITERATURE CITED

1. ASAMI, Y.: Pollen abortion in the Shanghai Peach. Journ. Sci. Agr. Soc. **297**: 364-372, 1927.
2. CONDIT, I. J.: The Kaki or oriental persimmon. Calif. Agr. Expt. Stat. Bull. **316**, 1919.
3. CORRENS, C. und GOLDSCHMIDT, R.: Die Vererbung und Bestimmung des Geschlechtes. Berlin, 1913.
4. CORRENS, C.: Untersuchungen über polygame Blütenpflanzen. I. *Silene Roemerii* FRIV. Sitzber. preuss. Akad. Wiss. **13**: 227-252, 1925.
5. CORRENS, C.: Bestimmung, Vererbung und Verteilung des Geschlechtes bei den höheren Pflanzen. Handb. d. Vererbungsw. IIc. Berlin, 1928.
6. Familler, I.: Biogenetische Untersuchungen über verkümmerte oder umgebildete Sexualorgane. Flora, **82**: 133-380, 1896.
7. GARDNER, V. R.: Studies in the nutrition of the strawberry. Missouri Agr. Expt. Stat. Res. Bull. **57**, 31 p. 1923.
8. HIERN, W. P.: A monograph of Ebenaceae. Transact. Cambridge Philosoph. Soc. **12**: 27-300, 1873.
9. KÔRIBA, K.: Entwicklungsmechanische Betrachtung über die Differenzierung der Geschlechtsorgane bei den Blütenpflanzen. Bot. Mag. Tokyo, **41**: 110-117, 1927.
10. KÔRIBA, K.: The differentiation of the sex in the plant. Proc. Jap. Assoc. Adv. Sci. **3**: 404-411, 1927. (Japanese).
11. LEVITSKY, G.: On the phenomenon of abortion in the organs of reproduction of *Asparagus officinalis* L. Bull. Applied Bot. Leningrad 1924/25, **14**: 113-142.
12. MAEKAWA, T.: On the phenomena of sex transition in *Arisaema japonica* BL. Journ. Coll. Agr. Hokkaido Imp. Univ. **13**: 217-305, 1924.
13. MAEKAWA, T.: Widerstands- und Selbstregulierungsvermögen gegen Geschlechtsänderung bei Hanfpflanzen und seine Beziehung zur Theorie der Geschlechtsbestimmung. Jahrb. f. wiss. Bot. **70**: 512-564, 1929.
14. NAMIKAWA, I. and HIGASHI, M.: On the number of chromosome in *Diospyros Kaki* L. f. and *D. Lotus*. L. Bot. Mag. Tokyo, **42**: 436-438, 1928.
15. NYI, TSU-KIANG: Observation on the sex differentiation and flower anatomy of *Firmiana simplex* WIGHT. (*Firmiana platanifolia* SCOTT and ENDL., *Sterculia platanifolia* L. f.) Contrib. Biol. Lab. Sci. Soc. of China, **5**, No. 3, 23 p. 1929.
16. OSAWA, I.: Cytological and experimental studies in *Citrus*. Journ. Coll. Agr. Imp. Univ. Tokyo **4**: 83-116, 1912.
17. OSAWA, I.: On the development of the pollen grain and embryosac of *Daphne*, with special reference to the sterility of *Daphne odora*. Journ. Coll. Agr. Imp. Univ. Tokyo, **4**: 237-264, 1913.
18. PRITCHARD, F. J.: Change of sex in hemp. Journ. Hered. **7**: 325-329, 1916.

19. ROHRHOFER, J.: Morphologische Studien an Staminodien der Bignoniaceae. Oesterr. Botan. Ztschr. **80**: 1-30, 1931.
  20. ROSA, J. T.: Sex expression in Spinach. Hilgardia, **1**: 259-274, 1925.
  21. SCHAFFNER, J. H.: Control of the sexual state in *Arisaema triphyllum* and *Arisaema Dracontium*. Amer. Journ. Bot. **9**: 72-78, 1922.
  22. SCHAFFNER, J. H.: The influence of the substratum on the percentage of sex reversal in winter-grown hemp. Ohio Journ. Sci. **25**: 172-176, 1925.
  23. SCHWARZE, C.: Vergleichende entwicklungsgeschichtliche und histologische Untersuchungen reduzierter Staubblätter. Jahrb. wiss. Bot. **54**: 189-242, 1914.
  24. SHOJI, T. and NAKAMURA, T.: On the dioecism of garden asparagus. (*Asparagus officinalis* L.) Jap. Journ. Bot. **4**: 125-151, 1928.
  25. SMITH, O.: Characteristics associated with abortion and intersexual flowers in the eggplant. Journ. Agr. Res. **43**: 83-94, 1931.
  26. VALLEAU, W. D.: Sterility in the strawberry. Journ. Agr. Res. **12**: 613-670, 1918.
  27. WHITAKER, T. W.: Sex ratio and sex expression in the cultivated cucurbits. Amer. Journ. Bot. **18**: 359-366, 1931.
  28. YAMPOLSKY, C.: Origin of sex in the phanerogamic flora. Genetica, **7**: 521-532, 1925.
  29. YASUI, K.: Studies of *Diospyros Kaki*. Bot. Gaz. **60**: 362-373, 1915.
-



# On the structure of "hobashira-ishi", a famous silicified trunk at Najima near Fukuoka City<sup>(1)</sup>

By Yudzuru OGURA

---

With plate III and 4 text-figures

---

(Received May 4, 1932)

"Hobashira-ishi" (meaning 'mast-stone') is a large silicified trunk lying on the beach at Najima, near Fukuoka City, Kiushiu. It is very famous because it is said to have been caused by the silicification of the mast of a ship which was used by the Empress JINGO, when she invaded Korea, 201 A. D. This tradition is, of course, unreliable; the trunk is of Tertiary origin.

This fossil trunk consists of several fragments; they lie in nearly a straight line, mostly exposed from the original rock, on a steep part of the beach (text-fig. 1). Some fragments are in contact, but some are separated by long spaces. Originally this should have been a long trunk embedded in the sand stone, which was broken into several fragments; some of these, after being exposed from the mother rock, may have been weathered, washed away by the wave, or taken away. According to the measurement in 1928 by SATO and KURITA (8, 9), the fragments were nine in number, eight being exposed, while one at the end partly enclosed in the sand stone. The length of these fragments is, in successive order from NW. toward SE., 91 130 58 140 112 67 97 50 x cm., the last one being unmeasurable as it is under the stone. The total length including the spaces between the fragments measures more than 14.55 m. All of the fragments are nearly cylindrical, and seven of them measure about 182 cm. in circumference, the other two being much smaller; these will be the upper part of the trunk. Near hobashira-ishi are found some other fragments of silicified wood em-

---

(1) Contributions from the Divisions of Plant-Morphology and of Genetics, Botanical Institute, Faculty of Science, Tokyo Imperial University, No. 116.

bedded in the sand stone or lying on the beach sand, some of which are the same kind of plant as hobashira-ishi, but others are different.

As to the nature of this hobashira-ishi, SATO and KURITA (8, 9) suggested it was one of the Fagaceae, but they gave no detailed description. In this district, the Tertiary formation is widely distributed including wide coal fields. Specimens of silicified wood are very abundantly found, especially in the coal fields; they are usually called "matsu-ishi" or "matsu-iwa" (meaning 'pine-stone'), the hobashira-ishi being believed to be one kind of matsu-ishi. As to the nature of



Text-fig. 1. The view of the beach of Najima where "hobashira-ishi" is lying broken into some pieces, eight of which are shown in the photograph.

this silicified matsu-ishi, KADOKURA (4) determined it to be *Cedroxylon* sp., but hobashira-ishi is really angiospermous wood, so that these specimens of silicified wood called matsu-ishi would include different kinds of plant wood, which the writer is now about to study.

The writer had formerly possessed some pieces of hobashira-ishi, and recently he had the opportunity of getting permission to obtain more pieces from the trunk, which, since some years ago, has been protected as a natural monument.

The following description refers to the anatomical structure of this fossil wood, which is so well preserved as to be worth describing.

### Internal structure

This wood is very hard and well preserved, but this does not apply to all parts, some being very badly preserved.

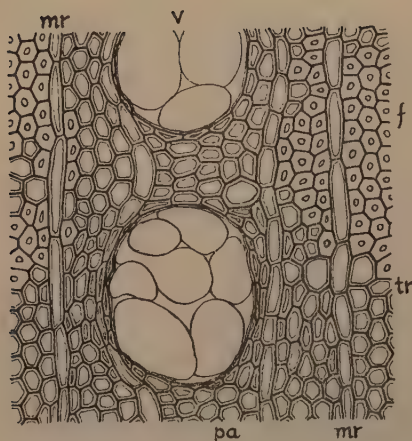
*Annual rings* are distinct, but are not very prominent. Under the microscope, they can be distinguished by the arrangement of vessels, but as the difference in size of vessels in spring and autumn woods is not very remarkable, the demarkation of the rings is not very prominent, and in some parts they are hardly distinguishable. They measure mostly 4-8 mm. in breadth (pl. III, fig. 1).

*Vessels* are very prominent owing to their large size and abundance (pl. III, fig. 2). They are distributed fairly uniformly, especially in the spring wood, but in the autumn wood they tend to be arranged in radial rows. All of the vessels are solitary, and are large in the spring wood, gradually diminishing towards the autumn wood. They are mostly elliptical in cross section, elongated in radial direction, the larger ones in the spring wood measuring  $230-270 \times 250-350 \mu$  and the smaller ones in the autumn wood  $60-100 \times 80-120 \mu$  in diameter. In 1 square mm., are found about seven large vessels or twelve small ones on an average.

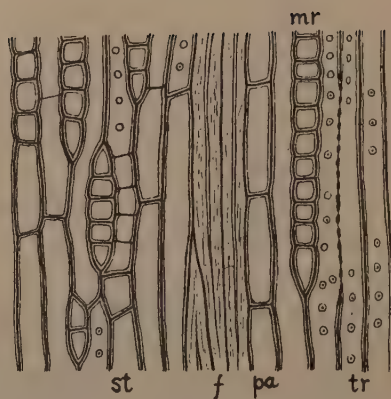
It is very noticeable that almost all of the vessels include prominent thyloses, the majority being completely full of them (pl. III, figs. 2-3; text-fig. 2). The formation of thyloses is well observable in longitudinal section; they originate from the parenchymatous cells round the vessel, projecting into the cavity of the latter just like a bladder, and then, owing to the mutual contact, each cell becomes polyhedral.

In longitudinal section, the boundary of the original vessel cells is clearly visible, because a remnant of membrane is left on the periphery of the vessel, which is horizontal or somewhat oblique, showing that the two vessel cells are penetrated by a large simple pore. Neither cell is constant in length, but is usually short; for example, in a vessel with a diameter of  $250 \mu$ , succeeding cells measure  $150-400 \mu$  in length (pl. III, figs. 4-5).

On the lateral wall of the vessel are small roundish pits, which are arranged in rows, pits on neighbouring rows being alternate. The detailed structure of the pit is not clear, but seems to be of bordered type.



Text-fig. 2. Cross section of the wood. (Compare pl. III, fig. 2)  $\times 60$   
v, vessel with thyloses; p, wood parenchyma; tr, tracheid; f, wood fiber; mr, medullary ray.



Text-fig. 3. Tangential section of the wood. (Compare pl. III, fig. 4)  $\times 60$   
st, septate tracheid or other intermediate forms between tracheid and parenchyma; other abbreviations as in text-fig. 2.

*Tracheids* and *wood parenchyma* are distinguished in cross section to some extent by the difference in size, but as this difference is only relative it is rather difficult to distinguish them. In longitudinal section, they are easily distinguished, the tracheids having a long fusiform shape and the parenchyma a short cylindrical shape with a horizontal wall; moreover, the tracheid is provided with small bordered pits, in one or two rows, on the lateral wall, while in the parenchyma the pits are indistinct. Both kinds of cells, however, cannot be distinguished, because there are intermediate ones, or septate tracheids, that is, the tracheidal cells separated by horizontal walls. These septate walls occur very abundantly but irregularly, and it is occasionally found that, though one part of a tracheidal cell is septate, another part remains unseptate (text-fig. 3).

Tracheids and parenchyma are abundant in the spring wood, and gradually diminish in amount towards the autumn wood, in which they are found round the vessels or among the fibers nearly in short tangential bands, though not regularly.

*Wood fibers* are distinguished from other elements by their thickened wall. They are few in amount in the spring wood and gradually increase toward the autumn wood, in which they are the fundamental



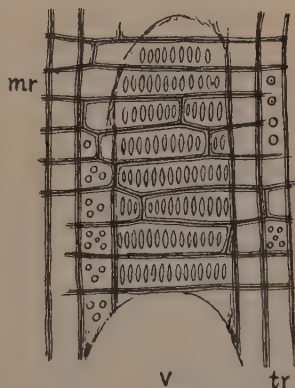
elements, so that the demarkation between the autumn wood and the next spring wood can be distinguished also by the arrangement of fibers.

Fibrous cells as well as parenchymatous and tracheidal cells are arranged radially, but this mode of arrangement is somewhat disturbed by the vessels. Generally, a fibrous cell measures  $15-20\ \mu$  in diameter and  $4-5\ \mu$  in membrane thickness. In longitudinal section it is a typical fusiform, both ends pointing out. Pits are obscure.

*Medullary rays* are of two kinds, the one uniseriate, the other broad compound. The former is very abundant in its occurrence, being found about fourteen to sixteen rays in the tangential breadth of 1 mm., so that between two neighbouring rays are usually only three to five rows of other elements. The rows of rays are greatly disturbed by the vessels, curving along the latter, and owing to the abundant occurrence and to the largeness of the vessels, it is rather rare that the ray runs straight in radial direction; it is therefore seldom possible to observe the ray in long form in radial section (pl. III, fig. 5).

In tangential section the ray is a long fusiform, 3-20 cells, in most case 10-16 cells, in height (pl. III, fig. 4). Each cell measures about  $20-25\ \mu$  in tangential breadth, but the radial length is very variable, usually being  $50-100\ \mu$ . On the membrane attached to tracheids are found small pits of bordered type, three to five in cross field, while on that attached to parenchyma are also found small pits, which seem to be simple. The most characteristic point is in the lateral wall attached to the vessels, on which are found large lens-formed pits closely arranged parallel to each other in horizontal direction (text-fig. 4).

The broad ray is rare in occurrence. Its breadth is variable, reaching more than  $300\ \mu$ , and the longitudinal length is very large; this could not be measured in the preparation. The ends taper gradually, so that it seems to be long fusiform. This ray is of a compound type, but it is not purely compound, and it includes a small amount of fibrous or tracheidal elements running longitudinally or obliquely, which are clearly visible in tangential section (pl. III, fig. 4). In some parts some rays with a breadth of a few cells are found near the broad ray



Text-fig. 4. Radial section of the wood. (Compare pl. III, fig. 5)  $\times 60$   
Abbreviations as in text-fig. 2.

separated by a few rows of xylem elements; this seems to be the transitional condition when about to aggregate into compound form.

### Affinity

As seen from the characteristics above described, it is clearly understood to be a typical angiospermous wood.

The mode of arrangement of vessels is considered as important characteristics in the determination of the wood. In the present wood, it seems to be generally diffuse, but in autumn wood it tends to be radial. Perhaps this wood may be of a radial type, but becomes rather diffuse owing to the abundancy and largeness of the vessels. Thyloses in the vessel are distributed in various groups of dicotyledonous woods, in some of which they are very prominent, for example, in *Quercus*, *Castanopsis*, *Morus*, *Robinia*, *Eusideroxylon*, *Cudrania*, *Varica*, etc. (cf. KANEHIRA (6), JANSSONIUS (3)).

It is not rare in dicotyledonous woods for the medullary rays to consist of uniseriate and broad ones, but it is rather rare that the broad ray is of a compound type, for example, *Casuarina*, *Quercus* (cf. KANEHIRA (6)).

Lens-like pits on the lateral wall of the medullary ray cells, which are in contact with vessels are very characteristic in this fossil; such a type of pits is rather rarely found, for example, in *Quercus*, *Shiia*, *Castanea*, *Castanopsis*, *Calophyllum* (cf. KANESHI (7)).

Considering these characteristics above described, this wood is very similar to *Quercus* among the living dicotyledonous woods. In the wood of this genus, indeed, like the present fossil, the vessel contains thyloses, and its wall is provided with bordered pits, the fibers are numerous among the autumn wood, the medullary rays are of uniseriate and compound types, and the pits between the vessel and the ray are lens-form (cf. ABROMEIT (1), KANEHIRA (6)). But, in this genus are found two types of woods owing to the arrangement of the vessels, that is, ring-porous and radial, the former being usually found in deciduous species and the latter in ever-green ones; the present fossil shows rather the latter type. But, comparing the present species with this kind of living *Quercus* woods, it differs from the latter in that the vessels are so numerous and large<sup>(1)</sup> that the radial

---

(1) According to KANEHIRA (6) the large vessels of living species measure 100–200  $\mu$  in diameter, though sometimes are much larger, according to ABROMEIT (1) up to 450  $\mu$ , while in the present species they are 250–350  $\mu$  in diameter.

arrangement becomes very obscure; in the living species this mode of radial arrangement is clearly shown, at least among the autumn wood. Moreover, though in the living species the vessels in the autumn wood are much smaller in comparison with those in the spring wood, the difference of size of vessels in the autumn and spring woods is not distinct in the present fossil. Again, though most of the living species have thyloses in the vessel it is rather rare for the vessel to be completely full of them (ABROMEIT (1)).

Fossil leaves related to *Quercus* have been found since the Cretaceous under such names as *Quercus* or *Dryophyllum*, but the woods which have been described as being related to *Quercus* have been found since the Tertiary under the names such as *Quercinium*, *Quercites* or *Quercus*. These woods already described are relatively few in number, for example, such as (cf. KAISER (5)) :—

*Quercinium subalosum* UNGER, in ENDLICHER Gen. plant. Suppl. II. p. 101, 1842; UNGER, Gen. et sp. plant. fossil. p. 405, 1850.

*Kloedenia quercoides* GÖPPERT, in LEONHARDT u. BRONN. Jahrb. f. Min. p. 518, 1838.

*Quercites primaeva* GÖPPERT, Uebersicht d. Arbeiten u. Veränderung d. schlesisch. Gesel. p. 219, 1846; Organ. Reste in Bernstein, I. p. 84, 1854; CONVENTZ, Über die versteinerten Hölzer aus dem nordd. Diluvium. p. 28, 1876.

*Quercinium primaevum* FELIX, Unt. über fossil. Hölzer. Zeit. deut. geol. Gesel. 35. p. 70, 1883.

*Quercus primaeva* GÖPPERT, Über die in der Geschiebeformation vorkommenden versteinerten Hölzer. Zeit. deut. geol. Gesel. p. 552, 1862; HOFFMANN, Über die fossilen Hölzer aus dem mecklenburgische Diluvium. p. 24, 1883.

From Austria, Hungary, and Silesia; Tertiary-Diluvium.

*Quercus subgarryana* CASPARY, Einige fossile Hölzer Preussens. p. 71, 1889. From Germany; Tertiary.

*Quercinium austriacum* UNGER, Chlor. protog. p. 29, 1841-47; UNGER, Gen. et sp. plant. fossil. p. 404, 1850. From Austria; Tertiary.

*Quercinium transylvanicum* UNGER, in ENDLICHER Gen. plant. Suppl. II, p. 101, 1841; UNGER, Gen. et sp. plant. fossil. p. 404, 1850. From Hungary; Tertiary.

Though these fossil woods already described have characteristics of *Quercus* they are clearly ring-porous, so that the present fossil differs from these woods, and may be a new species of wood related to *Quercus* or *Quercinium*; thus the following diagnosis may be given.

## Diagnosis

### *Quercinium hobashiraishi* sp. nov.

Angiospermous wood related to *Quercus*. Annual rings distinct, but not very prominent. Vessels generally diffuse, with tendency to be radial; large in spring wood, gradually diminishing toward autumn wood; solitary, seven to twelve per square mm.; elliptical in cross section, large ones  $230-270 \times 250-350 \mu$ , small ones  $60-100 \times 80-120 \mu$  in diameter; lateral wall with rows of small bordered pits; prominent thyloses within. Tracheids and parenchyma metatracheal and tangential, abundant in spring wood, scarce in autumn wood; lateral wall of tracheids with one or two rows of small bordered pits; intermediate forms between tracheidal and parenchymatous cells abundant. Wood fiber with thick wall abundant, especially in autumn wood. Medullary rays either uniseriate or broad; uniseriate ones abundant, 14-16 in breadth of 1 mm., 3-20 cells, mostly 10-16, in height; lateral wall with small pits; wall between vessels with rows of lens-form pits; broad rays rare, up to  $300 \mu$  in breadth, compound, including a few other elements.

Tertiary (Palaeogene); Najima near Fukuoka City, Kiushu; collected by Y. OGURA, 1932.

In conclusion the writer expresses his sincere thanks to Professors MIYOSHI and FUJII of Tokyo, and Professors KOKETSU and KOJIMA and Mr. SHIMADA of Fukuoka for the help in getting material.

April 1932

BOTANICAL INSTITUTE, FACULTY OF SCIENCE,  
IMPERIAL UNIVERSITY OF TOKYO

---

POSTSCRIPT. After this paper has been proposed, the writer determined another silicified dicotyledonous wood, which lies very near "hobashira-ishi" (cf. p. 174). The internal structure of this wood will be described in the following pages of this Journal under the title "On the structure of a silicified wood found near "hobashira-ishi" at Najima near Fukuoka City".

---



## Literature cited

1. ABROMEIT, J. (1884). Ueber die Anatomie des Eichenholzes. PRINGSH., Jahrb. f. wiss. Bot. Bd. **15**.
2. CASPARY, R. (1889). Einige fossile Hölzer Preussens. Abh. Geol. Specialkarte Preussen u. Thüring. Staat. Bd. **9**.
3. JANSSONIUS, H. H. (1906-30). Mikrographie des Holzes der auf Java vorkommenden Baumarten. Bde. **1-5**. Leiden.
4. KADOKURA, M. (1914). On the coals and "matsuishi" of Kasuya coal-field, Kiushu. (Japanese). Journ. Geol. Soc. Tokyo. Vol. **21**.
5. KAISER, P. (1890). Die fossilen Laubhölzer. I. Nachweise und Beläge. Leipzig.
6. KANEHIRA, R. (1926). Anatomical characters and identification of the woods of the Japanese Empire. (Japanese). Depart. of Forest. Governm. Research Inst. Formosa. Rep. **4**.
7. KANESHI, C. (1928-1931). Die Untersuchung über die Grundlage der Holzidentifizierungsmethode. I-IV. (Japanisch). Journ. Soc. Forest. Tokyo. Vols. **10-13**.
8. KURITA, T. (1929). Report on "hobashira-ishi" at Najima. (Japanese). Report Beautiful Scenery, Historic and Natural Monuments, Fukuoka-Ken. Vol. **4**.
9. SATO, D. and KURITA, T. (1930). On the natural monument of "hobashira-ishi", a silicified trunk, on the beach of Najima near Fukuoka City. (Japanese). Report Natural Monuments, Depart. of Education, Geol. & Min. Vol. **4**.
10. UNGER, F. (1850). Genera et species plantarum fossilium. Vindobonae.

## Explanation of plate III

*Quercinium hobashiraishi* OGURA

Fig. 1. Cross section of a part of the wood through four annual rings, showing the arrangement of vessels; the demarkation of the upper and lower rings is clear, but that of the median rings somewhat obscure.  $\times 10$

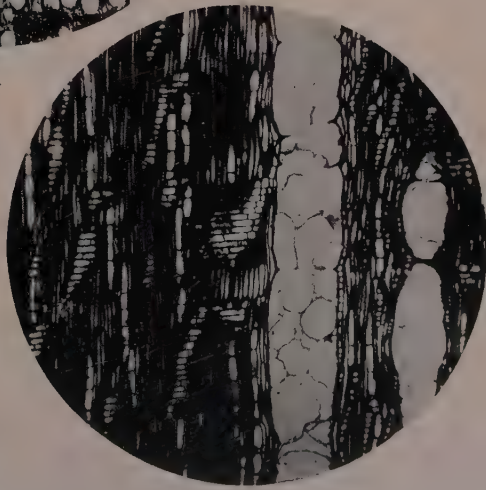
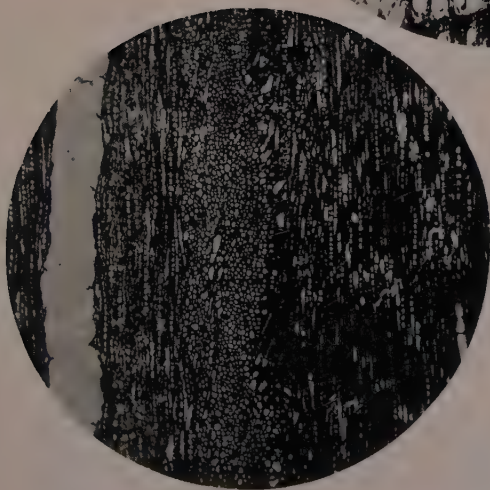
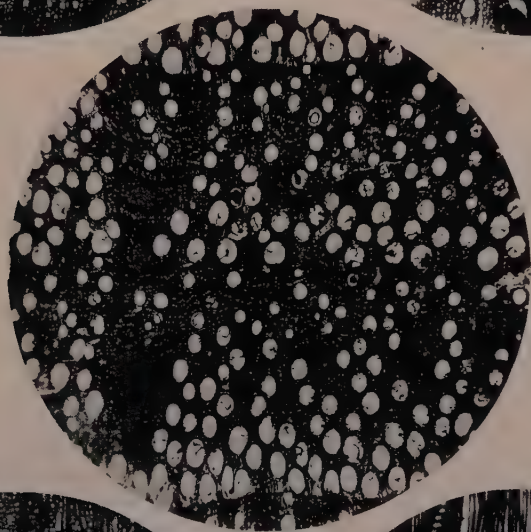
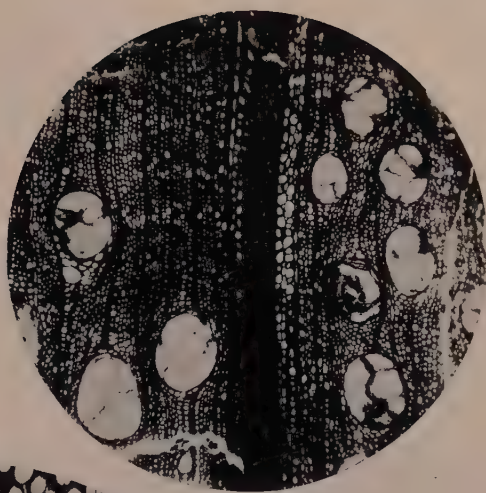
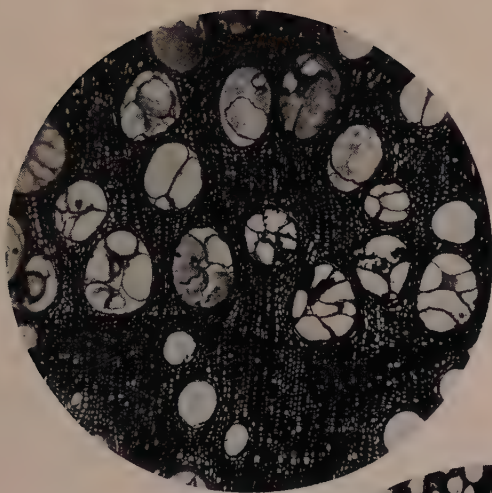
Fig. 2. One part of fig. 1 magnified, showing the demarkation of the annual rings and the vessels with thyloses; the medullary rays are all uniseriate. (Compare text-fig. 2)  $\times 30$

Fig. 3. Cross section of another part of the wood through the median region of the annual ring, showing the broad ray consisting of some cells wide.  $\times 30$

Fig. 4. Tangential section of the wood, showing the broad ray in center, numerous uniseriate rays in all parts, and the vessel in left; the broad ray contains some fibrous elements running vertically. (Compare text-fig. 3)  $\times 30$

Fig. 5. Radial section of the wood, showing the vessel with thyloses, medullary rays, wood parenchyma and other elements of the wood. (Compare text-fig. 4)  $\times 30$









# On the structure of a silicified wood found near "hobashira-ishi" at Najima near Fukuoka City<sup>(1)</sup>

By Yudzuru OGURA

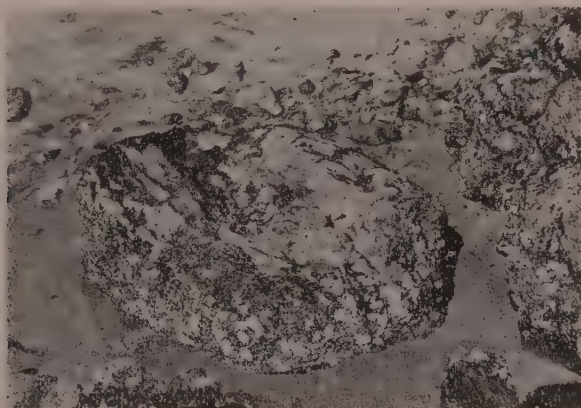
---

With plate IV and 4 text-figures

---

(Received June 5, 1932)

After the structure of "hobashira-ishi", a famous silicified wood at Najima near Fukuoka City, has been described (OGURA (6)), the writer made clear the structure of another silicified wood which lies very near hobashira-ishi. This is quite similar in external appearance, form, size and colour to hobashira-ishi, and the writer, as well as everyone who has seen it, believes to be one of its fragments washed away by the waves; its internal structure however is quite different from hobashira-ishi; really it is another dicotyledonous wood. This lies on the sand where it is immersed in the sea water at hightide; it lies about 4 m. northward from the terminal fragment (no. 1) of hobashira-ishi. It is a cylindrical rod, the length being 106 cm. and the circumference ca. 173 cm. (text-fig. 1).



Text-fig. 1. View of the silicified wood, *Phyllanthinium pseudo-hobashiraishi*, lying on sand below "hobashira-ishi"; view from "hobashira-ishi".  
(Photo. SHIMADA)

---

(1) Contributions from the Divisions of Plant-Morphology and of Genetics, Botanical Institute, Faculty of Science, Tokyo Imperial University, No. 117.

Another piece of silicified wood, of which the greater part is embedded in the sand stone on which hobashira-ishi is lying, is so badly preserved that the internal structure is obscure, but the arrangement of vessels and the feature of medullary rays suggest that it is of the same kind as the wood now in question. Perhaps, judging from the position in which they now lie, these two pieces may be the fragments of one and the same trunk, which is quite different from, but of the same age as hobashira-ishi. Another large silicified wood, lying on sand about 100 m. southward from hobashira-ishi, shows the same anatomical structure with the wood now in question.

### Internal structure

The preservation is fairly good, but nearly all of the cells except the vessels are full of brownish matter, which makes the structure somewhat obscure.

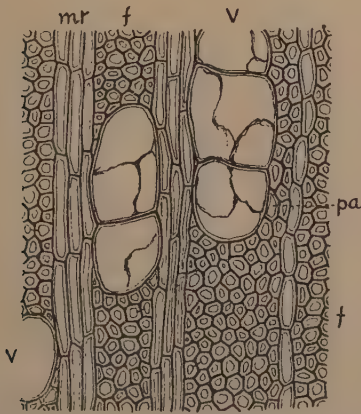
*Annual rings* are present but not very prominent. Under the microscope, they may be distinguished owing to the difference of size of the vessels in spring and autumn woods, but as their difference is not prominent the demarkation of the rings is sometimes obscure (pl. IV, fig. 1). They measure mostly 1–5 mm. in thickness.

*Vessels* are very prominent owing to their abundance (pl. IV, fig. 1). They are distributed rather evenly, but owing to the regular arrangement of medullary rays they show a tendency to a radial arrangement (pl. IV, fig. 2). They are solitary or grouped; in the latter case two to four vessels are attached closely in a radial direction, and occasionally two are in contact in a tangential or oblique direction. The groups consisting of two vessels occur most frequently, and solitary vessels or groups of three vessels are rather few (pl. IV, figs. 2–3; text-fig. 2).

Solitary vessels or vessel groups, somewhat smaller in the autumn wood, are oval in cross section and elongated in a radial direction, solitary ones measuring  $100\text{--}200 \times 70\text{--}140 \mu$ , mostly  $200 \times 100 \mu$ , in radial and tangential diameters. In vessel groups, two or three vessels are so closely in contact with their membrane that their contact edges constrict very slightly, and therefore the outline of the group is a long oval; the boundary wall of the neighbouring vessels is nearly tangential, though some irregularities occur frequently. A two vessels group measures  $160\text{--}250 \times 80\text{--}120 \mu$ , and a three vessels group  $250\text{--}350 \times 60\text{--}150 \mu$  in diameters respectively. In 1 square mm. are found 13–16 vessel groups or 23–40 vessels.

All of the vessels are full of large thyloses, the preservation of which is somewhat bad, the membrane being usually broken (pl. IV, fig. 3; text-fig. 2), but sometimes bubble-like cells are seen projecting into the vessel cavity out of the side wall. They are large, but not numerous, so that they may be able to expand to their full size within the vessel.

In longitudinal section, the segments of vessel cells are to be seen. The vessel perforation seems to be simple, the marginal parts of the end walls only remaining, which are fairly oblique. The segments are not constant in length; for example, in one vessel with a radial diameter of  $120\ \mu$  they are  $280\text{--}600\ \mu$ .



Text-fig. 2. Cross section of the wood. (Compare pl. IV, fig. 3)  
×60

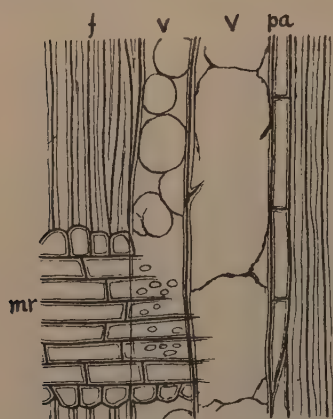
v, vessel with thyloses; pa, wood parenchyma; f, wood fiber; mr, medullary ray.



Text-fig. 3. Tangential section of the wood. (Compare pl. IV, fig. 4)  
×60  
Abbreviations as in text-fig. 2.

The structure of the membrane is not clearly visible, but it is enough to understand the outline of the pits. On the radial wall where two vessels are in contact are numerous bordered pits, which are oval,  $8 \times 11\ \mu$  in vertical and horizontal diameters; but owing to their close arrangement they show a tendency to be angular, so that the pitted part looks like a honey comb (text-fig. 3). In the center of each pit is seen a small spot which may be the entrance pore, and there is no doubt that the pits are of a bordered type. On the membrane where the vessel is in contact with parenchyma are seen elliptical pores lying

horizontally. They are arranged nearly in one vertical row, and fairly separate from each other; their size is variable,  $3-6 \times 8-16 \mu$  in vertical and horizontal diameters. The area of the pit is clear and seems to be of a simple type, but as the wall between vessel and parenchyma is generally of a semi-bordered type, the pits in this case may be semi-bordered. On the wall between the vessel and the ray cell there are also large pits just as in the case between the parenchyma. They lie horizontally, separate from each other, in one or two horizontal rows (text-fig. 4).



Text-fig. 4. Radial section of the wood. (Compare pl. IV, fig. 5) ×60  
Abbreviations as in text-fig. 2.

*Wood parenchyma* is very few in amount. It occurs round the vessels and can be distinguished from the fiber by its thinner wall, but as the form or size is nearly the same as the fiber cells the distinction is not always easy. In longitudinal section, however, the parenchyma is clearly distinguished by horizontal walls, the vertical length of each cell measuring  $100-300 \mu$  (text-fig. 4). On the end of this parenchyma row are generally found pointed cells, which suggest that the parenchyma may be septate or substitute fiber in its nature. On the membrane, no distinct pits are seen, but on that between the vessel are seen oval pits described above.

*Wood fibers* are the fundamental element of the wood (text-fig. 2). They are variable in size and very irregular in arrangement; in cross section most of the fiber cells are angular,  $18-26 \times 14-21 \mu$  in radial and tangential diameters. Their wall is not very thick, being  $3-4 \mu$ , so that in the center of each cell is a fairly large cavity, which is however filled with brownish matter. They are long in vertical direction, tapering toward both ends, the whole length being uncertain (pl. IV, fig. 5; text-figs. 3-4). On the wall where they attach themselves small pits are sometimes found.

*Medullary rays* are simple and evenly distributed, separated from each other by three to eight rows of fibers (pl. IV, fig. 3; text-fig. 2). They are one to four cells wide and fusiform in cross section (pl. IV, fig. 4; text-fig. 3). They may be distinguished in two modifications,



that is, uniseriate and multiseriate. Uniseriate rays, few in occurrence, are four to seven cells high, and differ from multiseriate ones in that they consist of erect cells, that is, the cells elongated vertically, but not horizontally; especially those on both sides are much elongated. Tri- or tetraseriate rays are most abundant, being 13–38 cells high, and though most of the ray cells consist of ordinary procumbent cells elongated radially, one or two rows at both ends are composed of erect ones (pl. IV, fig. 5; text-fig. 4). In a tangential section of the wood, two rays in a vertical direction are sometimes separated by a few rows of fibers somewhat curved, and often met with the ray constricted at the median part, which is caused by the fusion of such two vertical rays.

Each cell is fairly variable in size and form; ordinary cells measure  $20-30 \times 15-20 \times 100-250 \mu$ , while erect ones  $60-120 \times 15-25 \times 30-60 \mu$ , in vertical, horizontal and radial lengths respectively.

The membrane is thin, but each cell contains very dense brown matter, which makes the membrane very obscure. In this brown matter, transparent areas are frequently found which are generally rhomboidal and remind us of crystals. Small pits are often observable on the membrane, though the details are not clear. On the wall in contact with the vessel are found the large pits described above.

### Affinity

That this silicified wood is angiospermous is at once clear, but the determination of its affinity is rather difficult.

The mode of arrangement of the vessels of this wood is peculiar. When two or three vessels are grouped in one direction it is usual that they show a chain formation in cross section, constricted in the fused portion, but in the present wood their group is oval in outline, the constriction not being a prominent (radial septate type); this is due to the close contact of the neighbouring vessels and may be found in a few wood specimens, such as Euphorbiaceae, Celastraceae, Lauraceae, Lythraceae, Samydaceae (cf. JANSSENIUS (2), KANEHIRA (4), KANESHI (5)).

The presence of developed thyloses is another characteristic of the vessels, and though each cell is very large the amount is rather few; this is perhaps associated with the scanty occurrence of the wood parenchyma, so that this type of thyloses is rather rare in occurrence and is found in the specimens which are provided with few parenchyma.

The scantiness of the parenchyma is one of the most important characteristics of this wood. In most of the wood the parenchyma is fairly developed, usually in rows or masses, but some specimens have none or very few of them; then, the fiber occupies the fundamental part of the wood. Such are rather rare, and are found in such as Bixaceae, Celastraceae, Connaraceae, Hamamelidaceae, Combretaceae, Rubiaceae, Apocynaceae, Euphorbiaceae (cf. JANSSONIUS (2)).

The pits on the wall of vessels, when two of them are in contact with each other, are circular or somewhat angular, and arranged very closely; such a type is most commonly found in the dicotyledonous wood, and is of little value for identification. But, the simple elliptical pits, roughly arranged in a horizontal direction, on the wall between the vessel and the parenchyma or the medullary ray are not so widely distributed, and are found in such woods as Lauraceae, Anacardiaceae, Hamamelidaceae, Sabiaceae (cf. KANESHI (5)).

Considering these points of comparison, as well as other characteristics, the present fossil wood looks like Celastraceae (*Siphonodon*), Hamamelidaceae (*Altinga*), Samydaceae (*Casaria*, *Homalium*), Rubiaceae (*Guettarda*), Apocynaceae (*Orchippeda*, *Tabernaemontana*), Euphorbiaceae (*Bridelia*, *Phyllanthus*, *Glochidion*, *Bischofia*), Lauraceae (*Phoebe*, *Litsea*, *Tetradenia*), especially the last two families. In Lauraceae there are many specimens similar to the present fossil in the arrangement and pits of the vessels, but the parenchyma is much developed, while in the woody species of Euphorbiaceae the parenchyma is very scanty, and the arrangement and pits of the vessels, as well as other characteristics, show generally many similarities to the present wood. Especially, *Glochidion*, *Antidesma*, *Bischofia*, *Bridelia*, belonging to the tribe Phyllanthoideae, and *Croton*, *Acalypha*, *Macaranga*, belonging to the tribe Crotonoideae, seem to be similar, but none of them are quite the same as the fossil in every respect. *Bischofia*, for example, is one of those which are similar, but it differs in that the fiber is septate. Now, these genera of this family are tropical or subtropical plants, and most of them are found in Formosa; some, such as *Antidesma* and *Glochidion*, are found even in Kiushu, the locality where this fossil is lying.

In the fossil specimens of the dicotyledonous wood hitherto known, nothing is comparable to the present fossil (cf. KAISER (3)). At one glance, *Laurus biserata* CASPARY (1) from Prussia, for example, is similar to the present wood in the arrangement of vessels, but the ray is wider and the parenchyma is much more abundant.

It is, of course, impossible to determine the exact affinity of the fossil now in question only from the structure of the wood, but the writer considers it to be one of the Euphorbiaceae, especially of the tribe Phyllanthoideae, which is, however, different from any of the living species, so that it will be a new representative of this or a related family; the genus name *Phyllanthinium*<sup>(1)</sup> is given owing to its similarity to the tribe above described, and the specific name *pseudo-hobashiraishi* from the resemblance to "hobashira-ishi".

### Diagnosis

*Phyllanthinium pseudo-hobashiraishi* gen. et sp. nov.

Dicotyledonous wood with affinity to Euphorbiaceae. Annual rings present, but usually not clear. Vessels diffuse, with a tendency to a radial arrangement owing to medullary rays; solitary, or two to four grouped in a radial direction; 13-16 vessel groups or 23-40 vessels per square mm., solitary vessel oval in cross section,  $100-200 \times 70-140 \mu$  in diameter; grouped vessels oval in cross section, vessels in close contact; wall with closely arranged oval or angular bordered pits when in contact with each other; and with roughly arranged oval simple pits when in contact with parenchyma or medullary ray. Fibers constitute the fundamental mass of wood; typical long fusiform, angular in cross section; variable in size,  $15-25 \mu$  in diameter; irregular in arrangement; membrane thin,  $3-4 \mu$ , with small pits. Parenchyma very few; paratracheal; thin-walled; showing the nature of septate fiber. Medullary rays heterogenous; in two forms, uniseriate rays, rare in occurrence, 3-8 cells high, consist of erect cells; other rays 2-4 cells wide, 13-38 cells high, consist of radial cells flanked by 1-2 rows of erect cells; wall thin, with small pits.

Tertiary (Palaeogene); Najima (very near "hobashira-ishi") near Fukuoka City, Kiushu; collected by Y. OGURA, 1932.

May 1932

BOTANICAL INSTITUTE, FACULTY OF SCIENCE,  
IMPERIAL UNIVERSITY OF TOKYO

---

(1) In describing the fossil wood it is usual to use the suffix .....*xylon*, but .....*inium* was also used since UNGER. In the paper of "hobashira-ishi" (6) the writer used UNGER's name *Quercinium*, so that, in the present case *Phyllanthinium* is adopted instead of *Phyllanthoxylon*.

### Literature cited

1. CASPARY, R. (1889). Einige fossile Hölzer Preussens. Abh. Geol. Spezialkarte Preussen u. Thüring. Staat. Bd. 9.
2. JANSSONIUS, H. H. (1906-30). Mikrographie des Holzes der auf Java vorkommenden Baumarten. Bde. 1-5. Leiden.
3. KAISER, P. (1890). Die fossilen Laubhölzer. I. Nachweise und Beläge. Leipzig.
4. KANEHIRA, R. (1921). Anatomical characters and identification of Formosan wood. Taihoku.
5. KANESHI, C. (1928-31). Die Untersuchung über die Grundlage der Holzidentifizierungsmethode. I-IV. (Japanisch). Journ. Soc. Forest. Vols. 10-13.
6. OGURA, Y. (1932). On the structure of "hobashira-ishi", a famous silicified trunk at Najima near Fukuoka City. Japan. Journ. Bot. Vol. 6.
7. SOLEREDER, R. (1899). Systematische Anatomie der Dicotyledonen. Stuttgart.

---

### Explanation of plate IV

#### *Phyllanthinium pseudo-hobashiraishi* OGURA

Fig. 1. Cross section of the wood through six annual rings; the demarkation of the rings is slightly recongnizable by size difference of vessels.  $\times 10$

Fig. 2. One part of fig. 1 magnified, showing various forms of vessels; other tissues are not distinct in the photograph as they contain brownish matter in their cell cavities.  $\times 30$

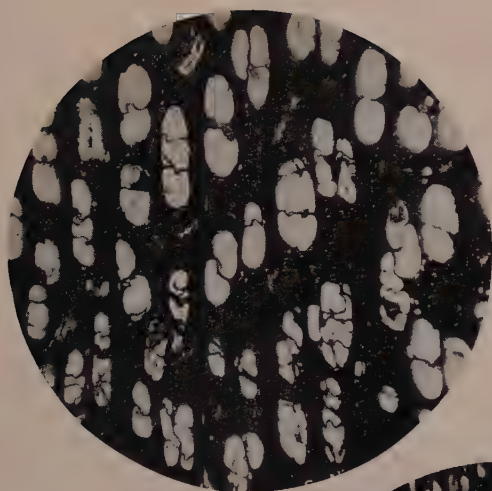
Fig. 3. One part of fig. 2 more magnified. (Compare text-fig. 2)  $\times 75$

Fig. 4. Tangential section of the wood, showing vessels with thyloses in longitudinal section and medullary rays in cross section. (Compare text-fig. 3)  $\times 30$

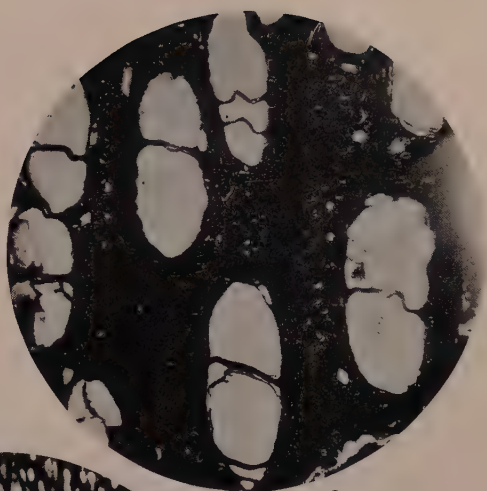
Fig. 5. Radial section of the wood, showing vessels and wood fibers in longitudinal section and medullary rays in radial direction. (Compare text-fig. 4)  $\times 30$

---





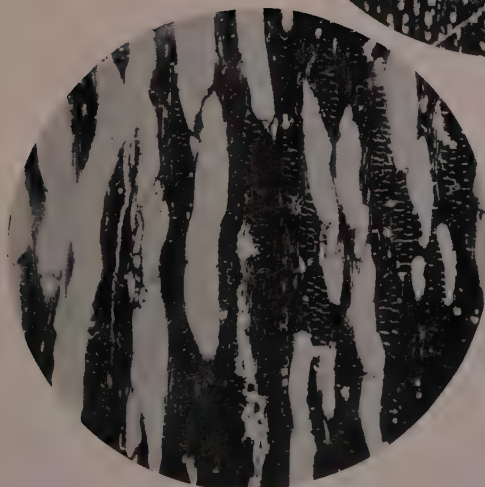
2



3



1



4



5



# **Hygronastic curling and uncurling movement of the leaves of *Rhododendron micranthum* TURCZ., with respect to temperature and resistance to cold**

By Yasona FUKUDA

---

With 14 text-figures

---

(Received May 25, 1932)

## **Sectional topics**

	Page
I. INTRODUCTION . . . . .	192
II. METHOD OF RECORDING THE DEGREE OF CURL . . . . .	193
III. MORPHOLOGICAL AND GENERAL FEATURES OF THE LEAF . . . . .	193
IV. TIME FACTOR IN CURLING PROCESS . . . . .	197
V. TEMPERATURE FACTOR IN THE CURLING AND UNCURLING PROCESS . . . . .	200
VI. EFFECT OF THE CLIMATIC CONDITIONS OF THE SEASON . . . . .	205
VII. APPLICATION OF THE GENERAL THEORY OF SOLUTIONS . . . . .	211
(1) The formula which indicates the relation between tempera- ture and the volume of a liquid phase of solution in a freezing process . . . . .	211
(2) The formulae which indicate the relations between tempera- ture and angle of the curvature of a leaf in curling up process . . . . .	212
(3) The formulae which indicate the relations between tempera- ture and angle of a leaf curvature in uncurling process . . . . .	213
VIII. RELATION BETWEEN THE THEORIES OF SOLUTIONS AND THE FREEZ- ING PROCESS . . . . .	215
IX. FLOW OF WATER INTO AND OUT OF A CELL . . . . .	216
X. OECOLOGICAL SIGNIFICANCE OF THE LEAF MOVEMENT . . . . .	217
XI. FACTORS IN RESISTING COLD . . . . .	219
XII. SUMMARY . . . . .	220
XIII. LITERATURE CITED . . . . .	224

## I. Introduction

Observations have been made by many scientists on the curling up movement of the leaves of certain species of Ericaceae. Among them may be mentioned the names of KERNER, CHRIST (1882), LIDFORSS (1901), FRANCÉ (1906), BERGEN (1906), HEGI (1906), FUJII (1912), NEGER (1913) and KIRCHNER, LOEW and SCHROETER (1923). The movement has been explained by some of them to be an ingenious means of resistance to draught and by others as resistance to cold. The movement is quite a significant phenomenon in plant life in Manchuria. Though situated in the north temperate zone, the land of Manchuria has a continental climate where the variation of temperature is very wide (50° C. day average). Summer green woods are the most common vegetation of the land, but such a climate is not conducive to the luxurious growth even of deciduous trees. The oecology of plants with ever-green broad-leaves grown under such climatic conditions may claim special attention. The lists of Manchurian plants prepared by various authors include only a few species of plants with ever-green broad-leaves, and all of them with the exception of *Viscum* sps. belong to the family Ericaceae, the leaves of which are known to present curling up movements. Two of them namely *Rhododendron dauricum* L. and *Rhododendron micranthum* TURCZ. are commonly found in Manchuria, the former in the north and the latter in the south.

The curling up movement of the leaves of these plants has so far been supposed, physiologically speaking, to occur as the direct result of the loss of turgidity caused by desiccation or as the indirect result of the formation, under a cold temperature, of ice in the intercellular spaces of leaf tissues. No comprehensive report on the study of the phenomenon, however, has yet been made. The author, believing that the phenomenon is worth careful study on account partly of its oecological importance and partly of the physiological interests attached to it, has conducted a series of investigations into the curling up movement of the leaves of *R. micranthum* TURCZ.

In publishing this paper the author expresses his gratitude to Professor Dr. Keita SHIBATA of the Tokyo Imperial University for his kind advice, to Professors Dr. Kenjiro FUJII of the same university and Dr. Kan KORIBA of Kyoto, and to Dr. Ichiro OHGA for their kindness in helping the author in preparing the list of literatures.



## II. Method of recording the degree of curl

It was assumed that the curvature of a leaf corresponds to an arc of a circle, and the angle at the center of the arc was measured to indicate the degree of curl (fig. 1). For this purpose models of curl in every 5 degrees of angles were made. Among them an analogical model to the curled leaf was adopted and the degree of the curl of the

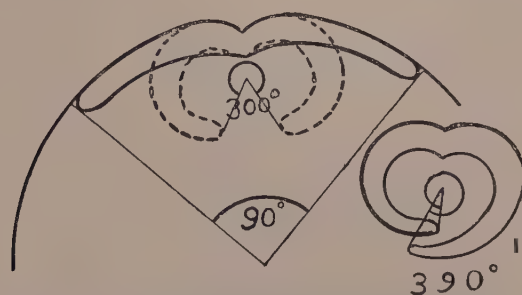


Fig. 1. Demonstration of the angles of the curvature of the curled up leaves.

model is recorded to indicate the degree of the curl of the leaf. If the dimension of the dorsal side is taken to be 1, then within the range of  $0^\circ$ – $360^\circ$  the exposed area of the ventral side diminishes by  $1/360$  in each degree of angles increased. Beyond  $360^\circ$  the exposed area diminishes in the same proportion on the dorsal side.

## III. Morphological and general features of the leaf

In cold weather the leaves of *R. micranthum* are entirely curled up and look deep black as if withered (fig. 2). When a branch with leaves which curled up owing to exposure to cold is brought into a room, the leaves uncurl at once and look as vivid just as in summer (fig. 3), and when that branch is taken back again into the open, they curl up in a few minutes.

If one leaf is torn into several portions (fig. 4) only the cooled portions curl up. If a leaf is torn into two, namely the dorsal side with palisade parenchyma and the ventral side with spongy parenchyma, the dorsal part shrinks slightly, while the ventral side shrinks considerably

through the contraction of the parenchymatous tissue. The cells of the spongy parenchyma are so connected with one another as to form a scaffolding-frame-work (figs. 5, 6 and 7). This frame-work easily narrows or broadens according to the loss or gain of turgidity. As the epidermal layer is closely filled with cells, leaving almost no open space



Fig. 2. Completely curled up foliage at the temperature of  $-8^{\circ}\text{C}$ .



Fig. 3. Do. Completely uncurled stage at the temperature of  $20^{\circ}\text{C}$ .

between them, it can not diminish its surface area to any considerable extent, and the contraction of the frame-work of the spongy parenchyma causes the furrowing of the epidermal layer of the ventral side.



Fig. 4. Leaves in which only the torn portions have been curled up in a cold air.

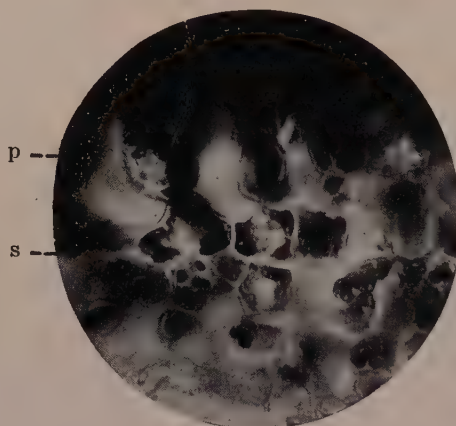


Fig. 5. Vertical views of the palisade parenchyma (p) and the spongy parenchyma (s). (*R. micranthum*)  $\times 430$ .

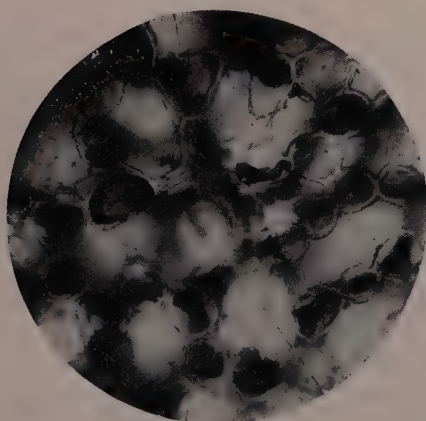


Fig. 6. Horizontal view of the spongy parenchyma. (*R. micranthum*)  $\times 430$ .

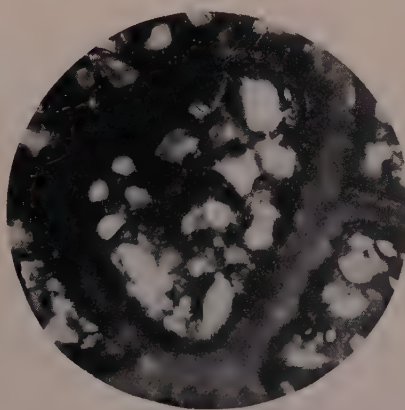


Fig. 7. Horizontal view of the spongy parenchyma. (*R. Metternichii* S. et Z.)  $\times 100$ .

The variation in the turgidity of a cell is caused by the change of temperature or by the desiccation of the tissue. Light has no effect on leaf-movements unless accompanied by heat radiated, for instance, by

direct sunshine. The leaf is fully protected from the influence of outside conditions other than temperature by means of the epidermis, and especially in the case of *R. micranthum* by shield-shaped hairs, so that the humidity of air or wind has no effect on the leaf-movement. This was proved by experiments undertaken in the former case by means of placing the object in a moist chamber or in a desiccator and in the latter case by blowing the object with an electric blower. Chloroform vapor had no effect on the leaf-movement within two hours or more, nor had immersion overnight in pure alcohol any effect on curled leaves if kept under a freezing temperature.

The protoplasm of *R. micranthum* presents vigorous resistance to outside conditions. If experimented in alcohol-water-exchange a thin cross-section of a leaf showed a curling and uncurling movement 20 times within 3 minutes. Afterwards the movement was somewhat lessened. The same section of a leaf was then placed in water for three minutes, and when experimented again in alcohol-water-exchange, it repeated the movement 15 times within the following 3 minutes. However, through the constant repetition of the movement the strength of the protoplasm became weaker and weaker, as is shown in the following table 1.

TABLE 1

Lassitude of plasm with repetition of the trial. A leaf is kept directly in the cooling agent of the ice-salt-mixture.

	Curvature angles in repeating trial												
	After 5 minutes in each trial in -5°C.										After 2 minutes in -8°C.		
No. of trials repeated	1	2	3	4	5	6	7	8	9	10	11	12	13
Degree of curvature attained	450	450	450	450	390	390	360	360	330	330	450	360	300

Table 2 shows the absolute values of the depression of the freezing-point of the cell sap of field specimens. The cell sap was extracted in accordance with the method of H. WALTER (1928), and the depression ( $\Delta$ ) of the freezing-point was measured cryoscopically.<sup>(1)</sup>

(1) Throughout the paper  $\Delta$  represents the absolute value of the depression of the freezing-point of a solution.



TABLE 2

Depression of freezing-point of the cell sap of the leaves. (*R. micranthum*).

Date	1929						
	Feb. 4	Feb. 18	March 4	April 4	April 28	Sep. 30	Dec. 8
$\Delta$	2.30	2.20	2.03	1.64	1.60	1.67	2.00

Date	1930			
	Jan. 26	Feb. 23	March 31	
$\Delta$	2.27	1.88	1.61	Taken from a sunny plot.
$\Delta$	2.08	1.81	1.49	Taken from a shady plot.

#### IV. Time factor in curling process

A thin broad leaf was preliminarily habituated to curling by a cooling agent and when kept in ice-water a while and then transferred into a cooling agent, it gave the following results in the process of curling, according to time (table 3).

Though the parabolic formula is suitable for the determination of the real maximum degree of curvature, the hyperbolic formula shows the most excellent agreement. If the tissue is allowed to become narrower indefinitely the origin ( $Y = 480$ ) may give the value of the maximum curvature of the curled leaf. Writing  $A$  for the maximum curvature, the formula (1)<sup>(1)</sup> takes the form

$$Y = A - A/(0.89t) \quad \text{for the case in } -4^{\circ}\text{C.} \quad (2)$$

The formulae of the same form were obtained as follows according to the experiments made under different temperatures :

$$\begin{aligned} Y &= 246 - 246/(0.2t) && \text{for the case in } -2.5^{\circ}\text{C.} \\ Y &= 563 - 563/t && \text{for the case in } -5.0^{\circ}\text{C.} \\ Y &= 682 - 682/(2t) && \text{for the case in } -8.0^{\circ}\text{C.} \end{aligned}$$

(1) See below table 3.

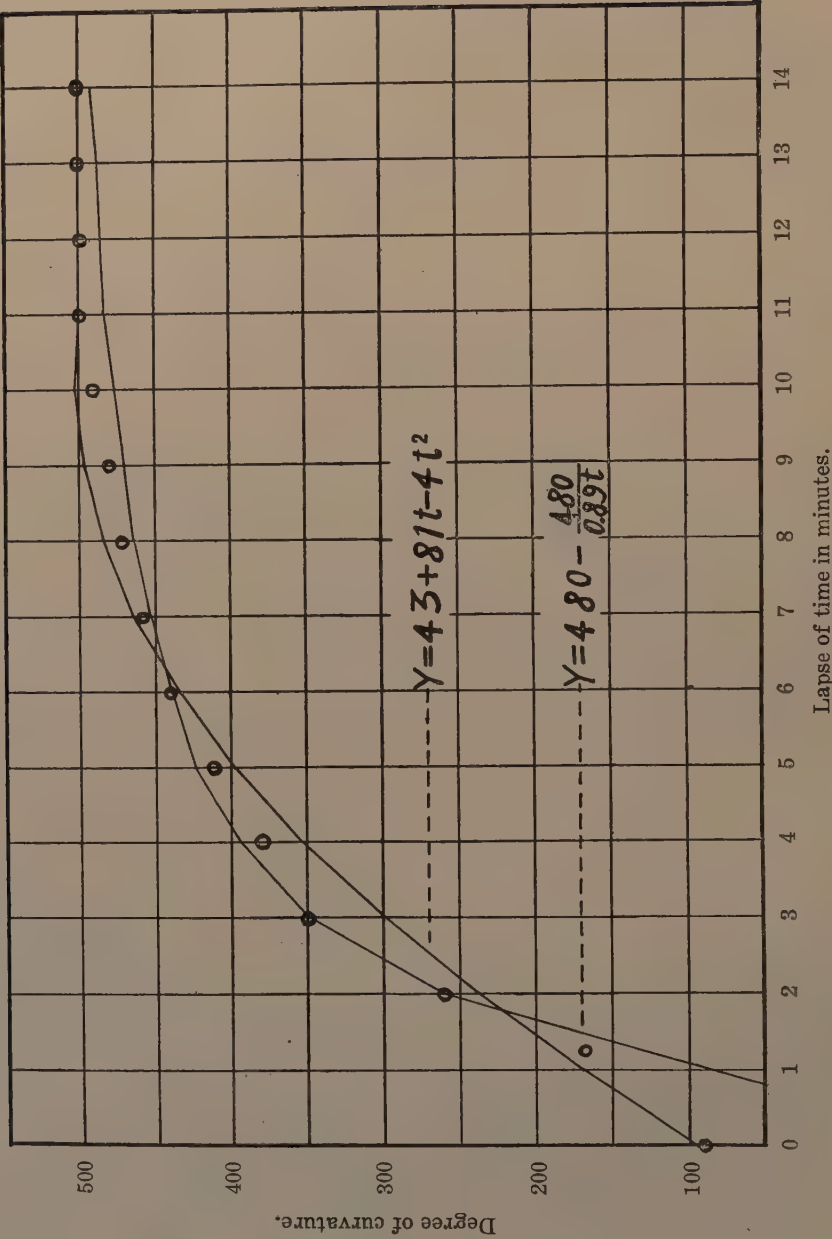


Fig. 8. Curling process according to time in  $-4^{\circ}\text{C}$ . Circles indicate the observation. (Tab. 3)

TABLE 3

Curling process according to time in  $-4^{\circ}\text{C}$ . For graph see fig. 8.

Minutes elapsed (t)	Degree of curvature		
	observed	calculated*	calculated**
0	40	43	—
1	120	120	—
1.5	120	—	120
2	210	189	210
3	300	250	300
4	330	303	345
5	360	348	372
6	390	385	390
7	410	414	403
8	420	435	412
9	430	448	420
10	440	453	426
11	450	450	431
12	450	439	435
13	450	—	438
14	450	—	441
Maximum	450	450	480

\* According to the equation  $Y = 43 + 81t - 4t^2$ \*\* According to the equation  $Y = 480 - 540/t$  (1)

The numerical coefficient of  $t$  may be regarded as the rate of the action of the temperature given. Writing  $q$  for this, we have the general formula

$$Y = A - A/(qt) \quad (3)$$

where  $Y$  represents the degree of curvature angle, and  $t$  time elapsed in minutes. The rate of the action ( $q$ ) of the temperature of the cooling agent has an increasing value in proportion to the lowering of the temperature of the agent. Thus the lower the temperature, the quicker does the curling proceed. From the results of experiments as shown in the above formulae (p. 197), we assign for  $q$  the values :

Temperature	Rate of action of temperature ( $q$ )	
	Observed	Calculated
-2.5°C	0.2	0.17
-4.0°C	0.89	0.66
-5.0°C	1.0	1.0
-8.0°C	2.0	2.0

In the above table the values of  $q$  are calculated according to the equation  $q = (1/3)(T-2)$ , where  $T$  represents the absolute value of the depression of temperature of the cooling agent. Writing  $k$  for  $1/3$  and  $\Delta$  for 2, the general equation is given as

$$q = k(T-\Delta)$$

where  $k$  and  $\Delta$  are the constant determined by the conditions of a given leaf. Substituting this formula for  $q$  in the equation 3, we have

$$Y = A - A / \{kt(T-\Delta)\} \quad (4)$$

According to the experiment referred to  $\Delta = 2$ , and this coincides with the absolute value of the freezing-point i.e. the depression of the freezing-point ( $\Delta$ ) of the cell sap. When  $T = \Delta$ , then  $q = 0$  and no curling movement takes place. Therefore  $\Delta$  in the equation may be regarded as the absolute value of the freezing-point of the cell sap of the leaf.

## V. Temperature factor in the curling and uncurling process.

Observation on the diurnal curling movement of a leaf was made from Oct. 24 to Dec. 23, 1930. Specimens used in this observation were grown in the half-shade during the growing season. The place where the observation was made was shaded by a building during the period when the observation was made, so that the effect of the direct sunlight could be avoided. The time necessary to obtain the maximum curvature under a fixed temperature was estimated to be about ten or twenty minutes, according to the temperature effect found by a laboratory experiment previously carried out. Therefore the effect caused by a lag of time factor could be avoided. The probable mean values of the



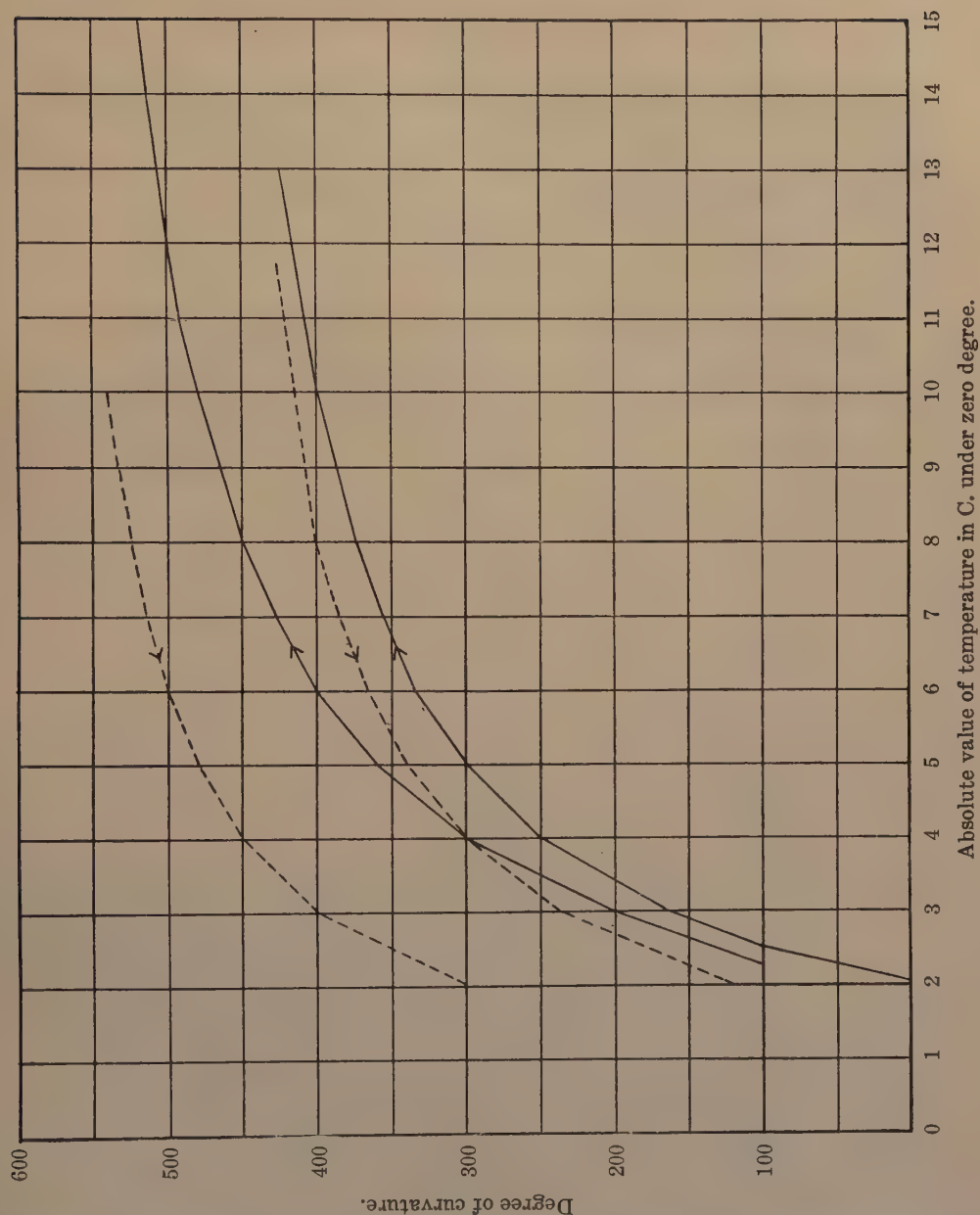


Fig. 9. Curling and uncurling processes of leaves under different temperature of the air.

The lower full line shows the curve of the curling process as observed on Nov. 2.

$$Y = 500 - 1000/T \quad (\text{tab. 4})$$

The lower dotted line shows the curve of the uncurling process as observed on Nov. 3.

$$Y' = 500 - 800/T \quad (\text{tab. 6})$$

The upper full line shows the curve of the curling process as observed on Dec. 17-22.

$$Y = 600 - 1200/T \quad (\text{tab. 5})$$

The upper dotted line shows the curve of the uncurling process as observed in December.

$$Y' = 600 - 600/T \quad (\text{tab. 8})$$

angles of the curvatures of the leaves, each of which has the dimension of about 26 mm × 12 mm, are given in the following tables. Table 4 gives those obtained by observations made in the early part of November, and table 5 gives those made in December.

TABLE 4

The effect of temperature on the degree of the curvature of the leaves in the curling process as observed on Nov. 2 and 3. For graph see fig. 9.

Temperature	Degree of curvature	
	Observed	Calculated*
-2.5°C.	120	100
-3.0°C.	150	167
-4.0°C.	240	250
-5.0°C.	300	300
-6.0°C.	330	333
-7.0°C.	350	357
-8.0°C.	370	375
-9.0°C.	390	389
-10.0°C.	400	400
-11.0°C.	410	409
-12.0°C.	415	416
-13.0°C.	420	423

\*According to the equation

$$Y = 500 - 1000/T \quad (5)$$

where  $T$  represents the absolute value of the temperature of minus degree.<sup>(1)</sup>

The uncurling process was very slow. It was distinctly observed on Nov. 3 (tab. 6). From that day onwards the curling and uncurling processes succeeded one another so that the effect caused by a lag of time factor became very complex. The more complex the alteration of the two processes, or the more rapidly the temperature changed, the larger was the lag. Tables 6, 7 and 8 show the results of observations on the uncurling process of the leaves on Nov. 3rd, Nov. 17th and 18th and in December respectively.

(1) Throughout the paper  $T$  represents the absolute value of the temperature of minus degree.

TABLE 5

Do., Dec. 17–22. For graph see fig. 9.

Temperature	Degree of curvature	
	Observed	Calculated*
–2.0°C.	120	0
–3.0°C.	200	200
–4.0°C.	300	300
–5.0°C.	360	360
–6.0°C.	410	400
–7.0°C.	430	429
–8.0°C.	450	450
–9.0°C.	470	467
–10.0°C.	480	480
–11.0°C.	490	491
–12.0°C.	500	500
–13.0°C.	510	508
–14.0°C.	515	514
–15.0°C.	515	520

\*According to the equation

$$Y = 600 - 1200/T \quad (6)$$

TABLE 6

The effect of temperature on the degree of the curvature of the leaves in the uncurling process as observed on Nov. 3. For graph see fig. 9.

Temperature	Degree of curvature	
	Observed	Calculated*
–3.0°C.	250	234
–4.0°C.	300	300
–5.0°C.	350	340
–6.0°C.	370	367
–7.0°C.	380	386
–8.0°C.	390	400
–11.0°C.	420	427

\*According to the equation

$$Y' = 500 - 800/T \quad (7)$$

TABLE 7

Do., Nov. 17-18.

Temperature	Degree of curvature	
	Observed	Calculated*
-2.0°C.	180	125
-3.5°C.	270	260
-4.0°C.	330	328
-5.0°C.	370	368
-6.0°C.	400	395
-7.0°C.	420	414
-8.0°C.	430	429
-9.0°C.	440	440
-10.0°C.	450	450

\*According to the equation

$$Y' = 530 - 810/T \quad (8)$$

TABLE 8

Do., in December. For graph see fig. 9.

Temperature	Degree of curvature	
	Observed	Calculated*
-2.0°C.	300	300
-3.0°C.	400	400
-4.0°C.	450	450
-5.0°C.	480	480
-6.0°C.	500	500
-7.0°C.	520	514
-8.0°C.	525	525
-9.0°C.	530	533
-10.0°C.	540	540

\*According to the equation

$$Y' = 600 - 600/T \quad (9)$$



Substituting the first term of the formula of curling up movement a suitable value ranging between 500 and 600 for 500 in the case of equation (6) and 600 in the case of equation (7), we may obtain a suitable equation of curling up movement on any day during the months of November and December.

## VI. Effect of the climatic conditions of the season

The results of observations of the diurnal curling and uncurling movements of the leaves made during November and December in 1930 are presented graphically in fig. 10. The daily maximum and minimum temperatures of the season were as follows (tab. 9).

No signs of leaf movement were observed during the month of October. The lowest temperature of the month was  $-2.8^{\circ}\text{C}$ . recorded on Oct. 31, when it snowed. On Nov. 1, when the snow was removed from a certain number of leaves, the leaves immediately began to curl up (fig. 11). One of these leaves (a) was very sensitive to temperature throughout the course of the observation, and its behavior is shown graphically by the lowest full line of the records of the angles of curvatures as presented in fig. 10. When snow on the leaves melted away naturally (fig. 12), the leaves gradually began to curl up (fig. 10). The angles of the curvatures of different leaves were not the same even under the same temperature. They varied according to the size, compactness and composition of the leaf, and perhaps partly to the difference of water supply from the stem. Small leaves at the end of a twig do not curl up so conspicuously as larger leaves, although to the naked eye all leaves appear to curl up to the same degree (fig. 13).

With the advance of the cold season the uncurling process delays and with it the angles of the curvature in the curling up process increase slightly, f.i. from Nov. 9 to 17 and from 21 to 26 in fig. 10. Late in the season leaves became curved even under a warm temperature. Such a phenomenon was observed during the period from Nov. 2 to 17, and it was ascertained that the water content of the soil was 11 percent on Nov. 17, while it was 24 percent on Nov. 2. Thereupon by means of irrigation the water content of the soil was restored at 5 p.m. on Nov. 17 to the former rate, namely 24 percent. Within 30 minutes of irrigation the leaves opened widely (Nov. 17 in fig. 10). Immediately afterwards the sun set, with a sudden drop of the air-temperature, and the curling up process set in immediately. The situation is shown in the following table 10.

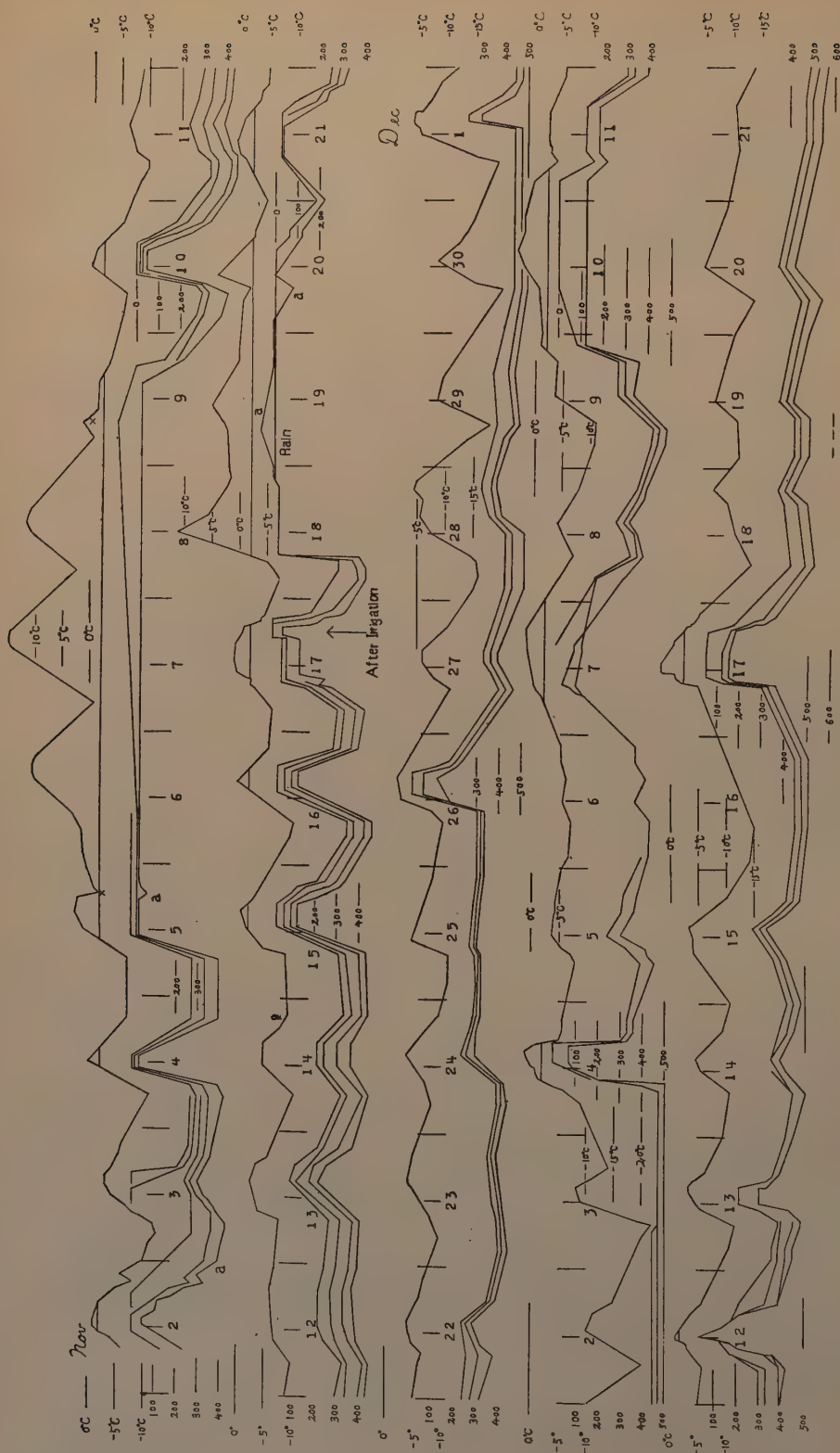


Fig. 10. Diurnal curling and uncurling movements of the leaves of *R. micranthum*. The results of the observations made during a period from Nov. 2 to Dec. 21 in 1930 are shown in five columns of the sets of lines. In each column the upper single line shows the temperature variations at the place where the plants grew, and the lower multiple lines show the degree of curvatures of the leaves. The lowest line marked (a) represents that of the most sensitive leaf.

TABLE 9

The maximum and minimum of the daily temperature in Mukden. (According to the report of the Mukden Branch of the Meteorological Station of the Government of Kwantung.) 1930.

Date	October		November		December	
	Max.	Min.	Max.	Min.	Max.	Min.
1	13.9	6.9	0.1	-9.7	-3.0	-21.9
2	6.9	4.1	-0.4	-11.1	-7.9	-21.5
3	14.0	4.9	-3.4	-14.2	-7.5	-23.2
4	19.1	1.6	-0.1	-12.2	1.5	-16.9
5	21.8	6.5	4.9	-10.0	-3.6	-7.7
6	24.1	7.5	12.2	-0.3	-5.6	-8.1
7	25.4	9.2	14.6	1.4	1.3	-6.0
8	25.1	10.1	11.4	2.7	1.3	-9.6
9	24.1	9.0	3.5	-5.3	-0.7	-11.9
10	14.6	4.5	-0.2	-8.5	3.0	-1.1
11	13.1	-1.2	-6.7	-11.2	2.4	-6.2
12	13.7	1.3	-3.7	-12.0	-1.8	-7.9
13	13.4	5.4	-2.5	-12.9	-2.1	-14.2
14	14.0	1.0	-2.0	-10.5	-3.7	-14.0
15	18.3	-0.1	0.1	-10.4	-3.9	-13.1
16	20.7	1.3	-1.3	-11.3	-6.4	-15.7
17	21.0	6.9	2.6	-8.1	3.2	-8.4
18	18.9	9.5	8.2	-7.8	-5.8	-14.7
19	12.4	3.4	5.1	0.0	-7.2	-12.8
20	12.3	2.1	0.2	-6.6	-4.5	-15.0
21	17.3	-1.4	2.2	-7.9	-9.1	-14.1
22	19.9	1.9	-3.1	-9.2	-6.2	-18.3
23	19.5	3.1	-3.4	-10.7	-2.0	-16.5
24	21.3	3.1	-0.8	-9.6	-2.1	-14.4
25	18.8	5.8	-0.8	-12.1	2.2	-11.7
26	13.4	2.4	0.0	-11.6	2.4	-12.1
27	13.9	3.1	-5.0	-12.9	-1.1	-8.5
28	13.9	1.5	-4.8	-16.1	-8.5	-15.9
29	9.3	1.6	-4.8	-16.4	-9.4	-19.9
30	4.0	-0.3	-5.8	-22.2	-9.3	-21.4
31	0.8	-2.8			-7.2	-18.3



Fig. 11. On the left branch leaves without snow on them curved to  $330^{\circ}$  (a) or to  $300^{\circ}$  (b) at  $-6^{\circ}\text{C}$ . on Nov. 1.



Fig. 12. The same branches which are presented in Fig. 11, showing different degrees of curving of different leaves on a branch. At  $-10^{\circ}\text{C}$ . at 8 o'clock p. m. on Nov. 2.





Fig. 13. Do. as in figs. 11 and 12. Normal condition of curving. At  $-7^{\circ}\text{C}$ . on Nov. 24.

TABLE 10

The effect of drought and irrigation on the degree of the curvature of the leaves in warm and cold temperature as observed on Nov. 17.

Date	Time	Temperature	Degree of curvature of the leaf					
			a	b	on the branch			
			on the same branch		u	v	w	
Nov. 17. a.m.	10.	−1.0°C.	135	120				Uncurling process
„	10.30'	0.0°C.	60	30				
„ p.m.	11.	0.5°C.	60	30				Effect of drought
	1.	1.0°C.	90	40				
	4.	0.5°C.	100	50				
	4.30'	0.5°C.	120	60				
„	5.	0.0°C.	120	60	30	30	30	Effect of irrigation
„	5.30'	−0.2°C.	45	20	0	0	0	
„	6.	−0.5°C.	45	20	0	0	0	
„	7.	−1.1°C.	45	20	0	0	0	Curling up process
„	7.30'	−2.8°C.	180	150	0	0	0	
„	7.45'	−3.5°C.	230	200	120	0	0	
„	8.	−3.8°C.	250	220	180	0	0	
„	8.15'	−4.0°C.	270	240	210	60	0	
„	8.45'	−4.5°C.	310	280	240	180	0	
„	9.	−4.6°C.	310	290	250	190	0	
„	9.30'	−4.7°C.	320	300	260	210	120	
18. a.m.	3.30'	−6.8°C.	420	390	330	310	300	

In the case mentioned above the leaf 'a' curled up to the same degree as was observed in the early part of November. Leaves on some branches commenced the curling up movement when the air temperature dropped to  $-2.8^{\circ}\text{C}$ . (u), those on others at  $-3.8^{\circ}\text{C}$ . (v) and others at  $-4.6^{\circ}\text{C}$ . (w). Distension of the cells with water retards the curling up movement. This was proved easily by experimenting with a branch with leaves severed from its stem. Therefore the supply of water from the warm soil might have retarded the curling up movement.

It rained for several hours from 8 p.m. on Nov. 18. Leaves commenced to curl up in the morning on Nov. 20, and when the curving was apparent the air temperature registered  $-2.2^{\circ}\text{C}$ . During the rain the most sensitive leaf 'a' spread  $30^{\circ}$  towards the dorsal side owing to distension by water, but it recovered its former form on Nov. 19 (fig. 10). When on Nov. 20 temperature fell to  $-1.6^{\circ}\text{C}$ . at 8 a.m., the leaf 'a' curved  $90^{\circ}$ . This indicates that a distended leaf does not keep that acquired state for long, but recovers its normal condition within a few hours, and that curling begins at a temperature a little higher than freezing-point of the sap as indicated by the behavior of the most sensitive leaf 'a'.

On Nov. 17 (tab. 8) the effect of drought, which causes a leaf curl up slightly appeared after the completion of the full uncurling process. A similar phenomenon was also observed on Dec. 7 (tab. 11).

TABLE 11

The effect of drought upon a leaf registered by the degree of the curvature after the completion of the uncurling process on Dec. 7.

Time	Temperature	Degree of curvature of the leaf		
		a	b	
a.m. 7.	$-1.6^{\circ}\text{C}$ .	160		Uncurling process
" "	$-1.4^{\circ}\text{C}$ .	140		
" 7.30'	$-0.8^{\circ}\text{C}$ .	110		
" 8.	$-0.4^{\circ}\text{C}$ .	90		
" "	$-0.4^{\circ}\text{C}$ .	90	30	Effect of drought
p.m. 3.	$1.0^{\circ}\text{C}$ .	120	90	
" 4.	$0.9^{\circ}\text{C}$ .	120	90	

## VII. Application of the general theory of solutions

### 1. The formula which indicates the relation between temperature and the volume of a liquid phase of solution in a freezing process

When a given solution changes its concentration ( $C_1$ ) to ( $C_2$ ), without changing the amount of its solute, the volume of the solution ( $V_1$ ) must be changed to ( $V_2$ ) in an inverse proportion to its concentration. The VAN'T HOFF's theory will then be written in an equation

$$V_2 = V_1(C_1 / C_2) \quad (10)$$

And as concentration is proportional to the depression of the freezing-point ( $\Delta$ ) of the solution,

$$C_1 / C_2 = \Delta_1 / \Delta_2 \quad (11)$$

From these two equations (10 and 11), we can find as follows the relation between the volume and the freezing-point of the solution,

$$V_2 = V_1(\Delta_1 / \Delta_2)$$

Writing  $\Delta$  for  $\Delta_1$  and  $T$  for  $\Delta_2$ , we have

$$V_2 = V_1(\Delta / T) \quad (12)$$

$$\text{or} \quad V_1 - V_2 = V_1 - V_1 \Delta / T \quad (13)$$

$V_1 - V_2$  is the loss of the volume of solvent theoretically. Similarly if the actual loss ( $y$ ) of the volume of solvent in a concentrating process is written to be  $V_0 - V$ , the loss may be

$$y = V_0 - V = V_0 - V_0 \Delta / T \quad (14)$$

This hyperbolic formula (14) may be applied to indicate the volume of the loss, which increases by ice-information in the freezing process, of a liquid phase of solution.  $V_0$  in this formula may be the maximum volume of the loss, for  $y = V_0$  when  $T = \infty$ . And  $V_0$  coincides with the original volume ( $V_1$ ) of the solution only in the case of ideal solutions.

## 2. The formulae which indicate the relations between temperature and angle of the curvature of a leaf in curling up process

In a solid mass whose two dimensions are fixed the variation of the volume corresponds to the variation of the third dimension. If in the curling up process of a leaf the difference between the length of the outer side and that of the inner side of a leaf may be regarded to be the variation of the third dimension of the cells of the spongy parenchyma, the variation of the curvature corresponds to the variation of the volume of the cell quantity. For the difference between the length of the outer arc ( $A$ ) and that of the inner arc ( $B$ ) is

$$A - B = 2\pi r\theta/(2\pi) - 2\pi(r-a)\theta/(2\pi) = a\theta \quad (\text{fig. 14})$$

where 'a' may be neglected as it corresponds to the total shrinkage of the leaf. Thus the difference between the length of the outer arc and that of the inner arc corresponds to the angle of the curvature observed in this experiment.

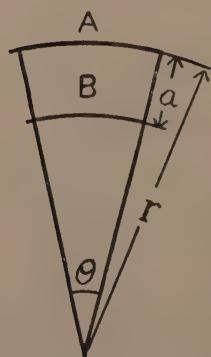


Fig. 14.

The formulae of the curling up process (5 and 6) will be written in the form of the formula (14), i.e.

$$y = V_0 - V_0\Delta/T$$

Then the formula (5)  $Y = 500^\circ - 1000^\circ/T$  will be

$$Y = 500^\circ - 500^\circ \times 2/T$$

The formula (6)  $Y = 600^\circ - 1200^\circ/T$  will be

$$Y = 600^\circ - 600^\circ \times 2/T$$

In the above formulae the value of  $\Delta$  is 2.00 in each equation. The value of  $\Delta$  coincides with the value measured cryoscopically of the depression of the freezing-point of the cell sap of the leaves of *R. micranthum*. Writing  $\Delta$  for the numerical value of it the formula (5) is

$$Y = 500^\circ - 500^\circ\Delta/T \quad (15)$$

and the formula (6) is

$$Y = 600^\circ - 600^\circ\Delta/T \quad (16)$$

The numerical value which corresponds to the  $V_0$  in the equation (14) is  $500^\circ$  in the equation (15) and  $600^\circ$  in the equation (16). Each of these



numerical values is the maximum angle of the curvature in each case, for  $Y = 500^\circ$  in the equation (15) and  $Y = 600^\circ$  in the equation (16) when  $T = \infty$  in both cases. Writing  $A$  for the angle required and  $M$  for the maximum angle of curvature, we will have the following general formula :

$$A = M - M\Delta/T \quad (17)$$

If time-factor is taken into consideration, the equation (4) must be applied to the equation (17). Now the equation (17) can be written

$$A = (T - \Delta)M/T$$

Substituting this value of  $A$  for the  $A$  in the equation (4), we will find

$$\begin{aligned} Y &= (T - \Delta)M/T - (T - \Delta)M / \{Tkt(T - \Delta)\} \\ &= \{T - \Delta - 1/(kt)\} M/T \end{aligned} \quad (18)$$

$$\begin{aligned} \text{or } Y &= M - M\Delta/T - M/(ktT) \\ &= A - M/(ktT) \end{aligned} \quad (19)$$

The lag ( $L$ ) caused by the time factor is denoted as follows by the third term of the equation (19) :

$$L = Y - A = -M/(ktT) \quad (20)$$

### 3. The formulae which indicate the relations between temperature and angle of a leaf curvature in uncurling process

When  $M$  is 500 and  $\Delta$  is 2.00 the formula of curling up process is

$$Y = 500 - 1000/T \quad \text{see (5)}$$

But under the same conditions the formula of uncurling process will be

$$Y' = 500 - 800/T \quad \text{see (7)}$$

So that the difference of the angles of the curvature between the curling and uncurling processes under the same thermal condition is

$$\begin{aligned} Y' - Y &= (500 - 800/T) - (500 - 1000/T) \\ &= 200/T \\ &= 100\Delta/T \end{aligned}$$

And the equation (5) indicates the situation of the leaf curvature effected by temperature, and the effect caused by a lag of time factor was avoided. Assuming that the protoplasm may occupy the same situation at the same temperature, this difference of the angles of the curvature between the curling and uncurling may be supposed to be caused not by the advance of the factors in the curling up process but by the lag of factors such as time in the course of the uncurling process. Taking  $M\Delta/T$  to be 1, the percentage ( $p$ ) of the lag will be

$$\begin{aligned} p &= (100\Delta/T)/(M\Delta/T) \\ &= 100/500 \\ &= 20\% \end{aligned}$$

In a similar way the percentage of the lag may be calculated

from the equation (8)

$$\begin{aligned} p &= \{(530 - 810/T) - (530 - 530 \times 2/T)\} / (530 \times 2/T) \\ &= 23.6\% \end{aligned}$$

from the equation (9)

$$\begin{aligned} p &= \{(600 - 600/T) - (600 - 600 \times 2/T)\} / (600 \times 2/T) \\ &= 50\% \end{aligned}$$

As the lag of the uncurling process is  $p$  percent of  $M\Delta/T$ , the lag ( $L'$ ) may be presented by the degree of added curvature as follows:

$$L' = (p/100)M\Delta/T \quad (21)$$

$$\begin{aligned} \text{or} \quad (p/100)M\Delta/T &= Y' - Y \\ &= Y' - A \end{aligned}$$

for  $Y$  in the equation (5) is written as  $A$  in the general formula (17); by transposition we have

$$Y' = A + (p/100)M\Delta/T$$

Since the value of  $A$  is given in the equation (17) as to be  $M - M\Delta/T$ , we have

$$Y' = M - M\Delta/T + (p/100)M\Delta/T$$

$$\text{or} \quad Y' = M - M(1 - p/100)\Delta/T \quad (22)$$

According to the observation, 'p' increases in proportion to the increase of the maximum degree of the curvature produced in a curling up process previously set in, and it increases also in the case of sudden change of temperature below the freezing-point. The former may be considered as the inner cause and the latter as the outer one of time factor. Moreover as the winter season advanced the leaves curled up more and more tightly.

### VIII. Relation between the theories of solutions and the freezing process

As has been stated VAN'T HOFF's law may be expressed in the following hyperbolic relation

$$y = V_0 - V = V_0 - V_0 \Delta/T \quad \text{see (14)}$$

From this the following formula can be deduced

$$A = M - M \Delta/T \quad \text{see (17)}$$

This formula was used to denote the effect of temperature upon the rate of the curling up process of the leaves of *R. micranthum*. The modification of this formula may be applied in the case of uncurling process. In this way the VAN'T HOFF'S law can be applied to denote the effect of temperature upon the leaf movement.

Cell sap is a concentrated solution and contains a relatively large quantity of solutes which cause hydration in the solution such as pentahydrate of sucrose (FINDLAY, 1919). Therefore if  $V_0$  is defined to be the volume of free water not bound in hydrates of solutes, the formula (14) holds good. Moreover cryohydrate is formed in the completely frozen stage (FINDLAY, 1923) and exists in cell vacuoles in the same stage (FUKUDA, 1932). Therefore the amount of the volume  $V_0$  as estimated above can not escape from the cell.  $M$  in the formula (17) is defined to be the maximum degree of curvature of a leaf in the curling up process. Such a curvature can only take place when the vacuole is completely emptied of free water. In the freezing process the curling up stops at the eutectic point and the maximum curvature which is defined in the equation is not attained. The fact that the maximum curvature in the completely frozen stage is attained at  $-15^\circ\text{C}$ . (tabs. 4 and 5) shows that the eutectic point of the cell sap lies in the neighbourhood of from  $-15^\circ\text{C}$ . to  $-20^\circ\text{C}$ . (FUKUDA, 1932).

## IX. Flow of water into and out of a cell

In the cryoscopical examination the sap pressed out from tissues displays remarkably the phenomenon of super-cooling. On the other hand in the course of curling up process plasmic contraction occurs before ice-formation. This may be due in natural conditions to the existence on the surface of the cell membrane of a diluted solution which commences freezing before the cell sap. Thus desiccated the cell membrane somewhat loses its swelling, and the contraction of such membrane induces the plasmic membrane to commence contraction. That low temperature causes the contraction of plasm has already been ascertained by GREELY (1901). As a result of this, the leaf commences curling shortly before the temperature of the cell sap reaches as low as the freezing point. Each one of the leaves, even on the same branch, commences curling at a different temperature, for instance, some under  $-1.5^{\circ}\text{C}$ . and some others at  $-2.0^{\circ}\text{C}$ . In the former case 1.5 must be taken as the value of  $\Delta$  in the equation (17). The supply of water from below causes a delay in the curling up of a leaf, and the desiccation of the soil causes an advance in the curling, and the rate of the curling up movement is accelerated by desiccation. When a leaf was induced to repeat curling and uncurling a lassitude of the plasmic contraction was observed. Therefore such a definition of the  $\Delta$  in the equation (17) as the freezing point of the cell sap must be discarded, and instead a new one defining it as the initial point of the temperature at which the leaf commences curling should be adopted. In a normal condition in autumn such an initial point approximately coincides with the freezing point of the cell sap. The curling up movement is therefore initiated by the plasmic contraction. This means that the plasm of this plant presents such colloid chemical features as to decrease the swelling of the plasm by so-called thermal response that is, strictly speaking, thermal influence. Water thrown out of a contracted cell may flow into intercellular spaces but in fact a greater portion of the water seems to flow into veins or into colourless parenchymatous cells.

The flow of water into and out of a cell takes place owing to the swelling and contraction of the plasmic membrane. However, change of the surface dimension of the cell membrane is also one of the main factors in causing the leaf curl up. When a leaf curls up the radius of a cell in the tissue of the leaf decreases, especially noticeably in a transverse direction, and evidently a diminution of the surface area of the



cell membrane takes place. A leaf dead from desiccation also curls up, and if it is immersed in water for several hours it uncurls. In such a case the movement is purely a hygroscopic one caused by the swelling of the cell membrane by the absorption of water. Therefore the fundamental cause of the occurrence of delay and advance in the leaf movement as mentioned above may be found in a condition of the cell membrane. For instance when water is abundantly supplied, the commencement of curling is retarded and on the other hand in the case of desiccation of the cell membrane it is accelerated. Therefore under such conditions a leaf seems to become more sensitive. Such a condition may easily be produced by bending down the stem of the leaf being tested. But a plant with a dead plasmic membrane can not make a leaf movement which looks a paratonic one. Therefore the author, although unable to find any special character of the paratonic feature, puts this movement as a hygromastic one according to the definition made by JOST and PFEFFER, which was recently adopted by E. HEINRICHER (1925) in his description of the opening and closing movement of the male flower of *Viscum*. The author, however, will refrain from stating that the phenomenon is one of thermonastic movements, although the leaf movement depends greatly upon the change of temperature.

In the equations (5) and (6) the variants  $\Delta$  are calculated to be 2.00 in each case, but  $M$  in the equation (17) has a value of 500 in the case of the equation (5) and 600 in the case of the equation (6). In reality as shown in the table 2, the cryoscopical values of  $\Delta$  must be higher in December than in November. Therefore the increasing concentration of the plant juice means the decrease of the water content of the plasm more than the accumulation of the solutes in the vacuolar sap. The decrease of the water content of the plasm allows the contraction of the plasm to take place more easily. In fact among *R. micranthum* the thermal response of leaves to curling up is very weak in summer when the cell sap is diluted and the swelling of the plasmic membrane does not diminish smoothly, but it is stronger in autumn when the cell sap is concentrated.

## X. Oecological significance of the leaf movement

Owing to the special structure of the leaf tissue of this plant the effect of the plasmic contraction can be observed macroscopically, whereas in many meso- and microthermic plants this effect is not macroscopic-

cally observable. In the latter case, however, it is microscopically assumed that ice-formation occurs only in intercellular spaces. There may be a wide fluctuation in the ability of plasmic contraction, and this may be considered to be one of the causes of hardness to cold. It seems that the plant becomes hardened to cold in proportion to the degree of the contracting ability of the plasmic membrane.

During the winter season the periodical alternation of brief periods of warm days and of cold days takes place; for instance in 1930 (tab. 9), a period of warm days succeeded Nov. 5-9, 18-20, Dec. 9-11 and 17 (fig. 10). This is one of the characteristics of the climate in Manchuria. The *Rhododendron*, with its leaves curling and uncurling according to the temperature of the air, seems to be able to adapt itself to such climatic conditions. The absorption of water from the soil during the long winter season is enabled by such periodical occurrence of comparatively warm days. IWANOFF (1925) gave a number of evidences to prove the existence even in winter of the root pressure in woody plant. Plant cells are in need of a supply of water from below. Some individual plants grown during winter on the desiccated soil died owing to the desiccation of the plant bodies. Even curled leaves tend to desiccate owing to the sublimation of ice when the water supply from below is cut off. The leaves so desiccated are thereafter unable to spread their leaf-blades even if the temperature of the air rises. The VAN'T HOFF's relation is applicable until the temperature of the air registers as low as  $-15^{\circ}\text{C}$ . as above mentioned. It is evident that the cell sap remains in a fluid condition until this low temperature is reached. Of course the normal water-movement in plants in winter proceeds very slowly, while the flow of water into and out of a cell in a leaf proceeds rapidly when the temperature of the air approaches the melting-point of ice. As a consequence of this, when the uncurling process is completed the leaf is fully spread, no matter whether the tree is slightly desiccated or not, and if the tree is slightly desiccated the leaf although spread fully at first commences later to curl up somewhat (tab. 9 and 10). This happens when the soil is quite desiccated, or the soil is frozen. In the latter case SCHIMPER's 'physiological dryness' worked in a similar way as the desiccated soil in causing the plant to desiccate. When the leaf of *R. micranthum* curls up, the epidermis is furrowed and the leaf surface is covered thickly with shield-shaped hairs grown together. The shield-shaped hairs of *Rhododendron* are known to have a glandular function secreting etherial oils (KRATSMANN). Such oils are serviceable for the protection of the plant both from the attack of animals, from the

excessive evaporation of water from leaves. The leaf of *R. Metternichii*, being thickly covered only with wooly hairs on its ventral side, seems to offer less resistance both to cold and to desiccation than the leaf of *R. micranthum*. Resistance to the hot summer climate and to the direct sunlight has played some role in the survival of this plant in South Manchuria where no other hardy ever-green broad-leaved Rhododendrons exist.

## XI. Factors in resisting cold

The leaf of *R. micranthum* has acquired its characteristic nature of hardness against the injurious effect of cold:

A. In order to protect the protoplasm of a cell from mechanical rupture during the freezing and thawing process. The protection of the plasm in this way is made possible by means of the decreasing or increasing swelling of the plasm. After irrigation the curling up movement of the leaves of some plants was considerably retarded owing to the distension of water in the cell-vacuoles, but some of such plants were later found dead.

B. In order to lower the lethal temperature of the plasm, by diminishing its swelling as the cold season advances. In the case of this species the lethal temperature lies below the eutectic point of the cell sap of the plant. The degree of the depression of the lethal temperature from the eutectic point is proportional to the water content of the plasm.

C. In order to protect leaf tissues from desiccation. As an indirect result of the thermal response the surface area of the leaf and the volume of the intercellular spaces are reduced and the leaf is reduced to a compact mass like a kind of a twig. By contraction into a sort of a twig, resistance to cold is considered to be heightened more than by remaining in the form of a broad leaf. Further the leaf is covered with a thick coat of shield-shaped glandular hairs.

This species of *Rhododendron* contains a large quantity of sugar as observed by several authors in respect of other species of *Rhododendron*. Sugar is regarded as a protective substance against cold (MAXIMOV). The author proposed that water bound in cryohydrates is serviceable for the protection of the cell from cold (FUKUDA, 1932), not only that, but such water as is found in the pentahydrate of sucrose (FINDLAY) is also beneficial for the cell in the frozen stage.

D. In order to allow of the absorption of water from the soil during the winter season, the cell of the leaf of *R. micranthum* contain cell



sap in high concentration. The concentration of the cell sap increases in late winter when the soil temperature falls considerably. The cell sap remains in a fluid condition until the temperature of the air become very low. In the case of the common plasmolysis the plasmodesma among the neighbouring cells are to some extent broken, but in the case of the freezing of this plant no plasmodesma are broken, and the wall of the vacuole of each cell is connected.

The present study confirms the author's view already published (FUKUDA, 1932), with a fuller explanation of some points raised.

## XII. Summary

1. Although a dead leaf of some of those species of *Rhododendron* whose leaves present curling up movements, curls up or uncurls hygroscopically, the curling up movement of the leaves of such species is one of hygronastic movements of the plant.

2. The hygronastic movement of the leaf is caused by the characteristic structures of the leaf of such species especially sensitive to the temperature at which plant fluid freezes. As a result, in the case of *R. micranthum*, *R. dauricum* or *R. Metternichii*, the leaf movement seems to be a thermonastic one.

3. The leaf movement is caused by the narrowing or broadening of the scaffolding-frame-work of the spongy parenchyma of the leaf.

4. The change of the size of the cell in the spongy parenchyma is caused by the decrease or increase of the swelling of the plasm. The speed of the movement therefore depends upon the condition of the plasm. Lassitude of the plasm appears when the movement is continuously repeated.

5. Although the degree of curvature of a certain leaf at a definite temperature remains constant after the leaf is exposed to that temperature for a certain time, the delay or advance of attaining that degree takes place according to the condition of the plasmic membrane and of the leaf itself.

6. The surface area of the cell membrane decreases or increases to a certain extent with the swelling or contracting of the plasmic membrane. The delay and advance of the process of deformation of the cell takes place according not only to the condition of the plasmic membrane, but also to the condition of the cell membrane, namely whether the cell membrane swells or contracts owing to the condition of water supply.



7. In the case of thermal response the movement commences at the temperature under which the cell sap freezes. But delay and advance of the commencement of the movement depends on the conditions of the cell membrane and as to whether they swell or contract according to the water supply from neighbouring tissues.

8. In the freezing process VAN'T HOFF's relation is applicable to the change of the volume of liquid phase of cell sap and also to the change of the volume of the cell, and this relation approximately holds good until the eutectic point of the cell sap is reached. In the leaf movement of *R. micranthum* and some other species of *Rhododendron* a similar relation which is adapted to the change of the volume of the cell is applicable to the change of the degree of the leaf movement, if the maximum value of the degree of the leaf movement is considered to coincide with the maximum degree of deformation of each cell in the leaf. In these species the effect of the change of the volume of the cell in the leaf is presented macroscopically in the form of the degree of the curvature of the leaf.

9. In the freezing process loss ( $y$ ) of the volume of solvent caused by ice-formation is presented according to the following modified hyperbolic formula of VAN'T HOFF's relation

$$y = V_0 - V_0 \Delta/T \quad (14)$$

where  $V_0$  is the maximum volume of free water not bound in hydrates of solutes. And this relation is approximately applied until the eutectic point of the solution is reached.

10. Relation between the degree of the thermonastic curling process and the lapse of the time during which the leaf of *R. micranthum* is exposed to a certain degree of temperature is presented by the degree of curvature angle ( $Y$ ) at a fixed temperature ( $T$ ) as a hyperbolic function of minutes ( $t$ ) elapsing from the commencement of the temperature action as in the following formula

$$Y = A - A/(qt) \quad (3)$$

$$\text{or} \quad Y = A - A/\{kt(T-\Delta)\} \quad (4)$$

where  $A$  is the maximum curvature angle at a fixed temperature;  $k$  and  $q$  are the constants determined by the condition of a given leaf; and the relation between  $k$  and  $q$  is

$$q = k(T-\Delta)$$

11. Relation between the degree of the thermonastic curling process and the temperature of the air to which the leaf of *R. micranthum* is subjected is presented by the degree ( $A$ ) of the maximum curvature angle at a certain temperature ( $T$ ) as the following formula presenting the hyperbolic function of temperature ( $T$ ) of the air

$$\begin{aligned} A &= M - M\Delta/T \\ &= (T - \Delta)M/T \end{aligned} \quad (17)$$

where  $M$  is the maximum angle of the curvature which the given leaf would attain where the volume of water bound in cryohydrate should be added in the calculation of the volume of free water.

12. If in the above case the time factor is considered in the relation between the curling movement and the temperature of the cooling agent, the relation is presented by the degree of curvature angle ( $Y$ ) of the leaf which has been exposed for  $t$  minutes at the temperature ( $T$ ) of the cooling agent. This relation is in turn presented as the following hyperbolic formula of the function of temperature and time

$$Y = \{T - \Delta - 1/(kt)\}M/T \quad (18)$$

$$= M - M\Delta/T - M/(ktT) \quad (19)$$

The delay ( $L$ ) of the curling process caused by the time factor is presented by the degree of the reduced curvature as follows

$$L = Y - A = -M/(ktT) \quad (20)$$

13. Relation between the degree of the thermonastic uncurling process and the temperature of the air, to which the leaf of *R. micranthum* is subjected, is presented by the degree ( $Y'$ ) of the curvature angle at a certain temperature ( $T$ ) as the following formula of hyperbolic function of temperature ( $T$ ) of the air

$$Y' = M - M(1 - p/100)\Delta/T \quad (22)$$

where  $p$  is the constant percentage of the delay determined by the inner and outer conditions of a given leaf. For the standard of the percentage  $M\Delta/T$  is taken to be 1, so that the delay ( $L'$ ) of the uncurling process may be presented by the degree of added curvature as follows

$$L' = Y' - A = (p/100)M\Delta/T \quad (21)$$

14. Seasonal variants  $\Delta$ ,  $M$ , and  $A$  have the lowest value in summer and the highest in the late winter and tend to increase according to the advancement of the cold season and slowly decrease according to the progression of the warm season, except the value of  $A$  which decreases very little on the latter course.

15. The change of the value of  $A$  in the equation (17) is caused by the change of the degree of a swelling of the plasm of the cell. The degree of the swelling of the plasm decreases in proportion to the increase of the concentration of the cell sap.

16. The oecological significance of the leaf movement of *Rhododendron* has been considered in this paper with special reference to the question that, with the exception of *Viscum* sps., *R. micranthum* is the only plant with ever-green broad-leaves existing in South Manchuria where the year variation of the temperature is very large (50°C. day average).

17. In regard to the hardiness against cold in ordinary terrestrial plants found in the temperate zone the present study not only endorses the author's view (see literature 7, p. 224) but gives a more complete explanation of it in certain phases.

MANCHURIA MEDICAL COLLEGE,  
JAPANESE CITY,  
MUKDEN

---

## XIII. Literature cited

1. BERGEN and DAVIS : Principles of Botany. 1906.
  2. CHRIST : Das Pflanzenleben der Schweiz. 1882. (*Erica tetralix*).
  3. FRANCÉ, R. H. : Das Leben der Pflanze. Bd. 1, S. 29, 1906.
  4. FUJII, K. : Botanical excursion to Mt. Fuji in winter. Bot. Mag. Tokyo, Vol. 26, 1912.
  5. FINDLAY, A. : Osmotic pressure. London, 1919. p. 66-68.
  6. DO : The Phase rule and its applications. London, 1923.
  7. FUKUDA, Y. : A study on the conditions of completely frozen plant cells, with special reference to resistance to cold. Bot. Mag. Tokyo, Vol. 46, No. 544, 1932.
  8. GREELEY, A. W. : Am. Jour. Physiol., 6, 112-128, 1901, cited by DUGGAR in Plant Physiology, New York, 1922.
  9. HEGI, G. : Illustrierte Flora von Mittel-Europa. Bd. 5, Teil 3, S. 1632, 1906.
  10. HEINRICHER, E. : Hygronastische Öffnungs- und Schliessbewegungen bei den männlichen Blüten der Mistel (*Viscum album* L.). Ber. d. Deutsch. Bot. Ges., 43, 366, 1925.
  11. IWANOFF, L. : Zur Kenntnis des Wurzeldrucks bei den Holzgewächsen. Ber. d. Deutsch. Bot. Ges., 43, 373, 1925.
  12. KERNER, A. : Pflanzenleben, cited by FRANCÉ.
  13. KIRCHNER, O., LOEW, E. und SCHROETER, C. : Lebensgeschichte der Blütenpflanzen Mitteleuropas. 4, 1 Abteil., Ericaceae, 1923.
  14. MAXIMOV : The plant in relation to water. 1929.
  15. NEGER, F.W. : Biologie der Pflanzen. S. 71, 1913.
  16. SCHIMPER, A.F.W. : Plant-geography upon a physiological basis. English trans. by FISCHER, revised by GROOM and BALFOUR, p. 2, 1903.
  17. WALTER, H. : Über die Presssaftgewinnung für kryoskopische Messungen des osmotischen Wertes bei Pflanzen. Ber. d. Deutsch. Bot. Ges., 46, 589, 1928.
-



# On the reappearance of haploid in the Japanese morning glory

By Nagaharu U

---

With plates V-IX and 9 text-figures

---

(Received June 5, 1932)

## Contents

I. Introduction . . . . .	225
II. Description of the haploid . . . . .	226
III. Description of the grafted haploid scions on <i>Ipomoea edulis</i> , MAKINO. . . . .	227
IV. Mutation observed in one shoot of the haploid . . . . .	227
V. Cell measurement . . . . .	228
VI. Cytology of the haploid . . . . .	230
(1) Observation on somatic chromosomes . . . . .	232
(2) Observations on P.M.C. . . . .	232
VII. Discussion . . . . .	238
VIII. Summary. . . . .	241
Literature cited . . . . .	242
Explanations of plates V-IX. . . . .	243

## I. Introduction

In an earlier communication the author reported preliminarily the occurrence of a haploid in the Japanese morning glory, *Pharbitis Nil*, CHOIS. It appeared in 1930 in the  $F_1$  progenies resulting from the cross of a yellow-leaved, white-flowered normal plant ( $AA$ ) with the green-leaved, red-flowered 'Primary Intermediate Form' which is a periclinal chimera composed of the eversporting 'Pine Inconstant' ( $\alpha'a'$ ) and the epidermis of the normal ( $Aa'$ ), (pl. V, fig. 1 and pl. IX, figs. 11-14) (s. Jap. Jour. Gen. 6, Nos. 3-4.). Among the 285 vigorous green-leaved  $F_1$  plants with coloured flowers a dwarf, slender individual, was observed showing the recessive yellow leaves and white flowers like its mother (pl. V. fig. 2). But in every stage of its development the whole appear-

ance was remarkably distinguishable from its mother plant, and when it reached its maturity it was found almost to be completely sterile, the sexual cells, both micro- and megaspores, showing a high degree of abortion. Subsequent cytological investigation has shown this to be a haploid. But, unfortunately, before further detailed studies were completed, all the important data including the cytological preparations were consumed by the fire which broke out in our laboratory late in the same year.

In 1931, however, a quite similar plant was observed among the 300  $F_1$  progenies of the same cross. In its growth habit it showed striking resemblance to the above-mentioned haploid. Cytological studies proved it again to be a haploid.

## II. Description of the haploid

The haploid plant in 1931 was easily distinguished from the sister plants by its small cotyledons and slender hypocotyl showing the recessive yellow colour. Pl. VI, fig. 3 shows its early stage of growth photographed at about 2 weeks after germination. Vegetatively it was normal in appearance and passed through its growing period quite healthily. After 40 days it reached the flowering stage and some of the more striking differences were shown in pronounced contrast to the typical diploid (pl. VII, fig. 8). In all its parts it showed considerable diminution, especially the internodes were short and numerous. The leaves were small and the extremities of both lobes were frequently roundish. On about fifty fully developed leaves comparisons in size were made between the haploid and the diploid, the results of which are recorded in table I (pl. VI, figs. 6-7). The corolla also showed remarkable dissimilarities in both size and form to that of the normal diploid (pl. VI, figs. 4-5). Owing to the projecting extremities of the rays it is almost regularly pentagonal and appears like that of *Campanula*. Table II shows the difference in diameter of corolla between the haploid and the diploid. In respect to the sexual organs they are normal in all instances, except that the style and filament are more slender and shorter. However, as frequently observed, anthers do not open until the flower fades away, so that pollen remains undischarged. The pollen grains are greatly variable in size and highly abortive. The haploid, as described above, was almost completely sterile in this year, although in 1930 nine seeds from five capsules were obtained by back-crossing it to the diploid.

TABLE I

Comparison of leaf size between the mother plant and the haploid.

	No. of leaves observed	Mean length (cm.)	Comparison	Mean width (cm.)	Comparison
Mother plant	56	8.04	100	8.89	100
Haploid	54	4.27	53	3.76	42

TABLE II

Comparison of diameter of corolla between the mother plant and the haploid.

	No. of corollas measured	Mean diameter (cm.)	Comparison
Mother plant	30	7.04	100
Haploid	18	4.39	62

### III. Description of the grafted haploid scions on *Ipomoea edulis*, MAKINO

For the purpose of continuing the haploid by an asexual method several shoots were taken and grafted on sweet potato, *Ipomoea edulis*, MAKINO. A method of whip grafting was used and the operation was done in a greenhouse. In general successful graft unions were easily secured and the scions grew fairly well. In every respect the scions underwent no particular influences by the grafting, and survived long after the death of the original haploid, but they died also early in the following winter with the formation of tubers characteristic of the stock (pl. VIII, fig. 9).

### IV. Mutation observed in one shoot of the haploid

Of particular interest in this haploid was the occurrence of mutation in one of its shoots. As has already been reported (U 1931) the haploid obtained in 1930 also underwent mutation in one shoot and it bore a typical 'Pine'-like corolla. In this case, however, the mutation exhibits itself in somewhat different way. As shown in pl. VIII, fig. 10 the shoot in question bears leaves much more smaller and

wrinkled. But the flowers borne on it showed no particular differences compared with those of the other shoots.

Although a gene mutation, either dominant or recessive, occurred in a haploid, it may be more easily recognizable in it than in a diploid; the facts above-mentioned suggest that the haploid genome is perhaps not fully sufficient for the stable development of an individual, whence the frequent occurrence of mutation.<sup>(1)</sup>

## V. Cell measurement

Not only is the haploid conspicuously smaller than the normal as described above, but also the cells constituting its tissues are noticeably reduced in size. Although detailed studies on cell size were not undertaken in every tissue of the haploid in comparison with that of the diploid, some measurements of epidermal cells of stem, leaf, and flower, including P.M.C.'s were made, and the results are given in table III.

TABLE III  
Cell measurement.

	Cells measured	Mean length		Mean width	
		Haploid	Diploid	Haploid	Diploid
Petal (epidermis)	40	88	100	77	100
Leaf (epidermis)	40	62	„	55	„
Stem (epidermis)	40	62	„	59	„
Stigma cells	40	62	„	66	„
Anther (epidermis)	45	60	„	60	„
P. M. C.	40	77	„	77	„

In measuring the cell size two methods were employed. In one case, the cell outline drawn by means of camera lucida was measured, and in another an ocular micrometer was used. The comparisons are given not in actual length but in the % of normal diploid cells. In measuring the cells of the epidermis they are regarded as horizontally placed rectangles. In calculating the size of the P.M.C. they are assumed to be horizontally lying ellipses.

(1) It may be noted that in  $F_2$  I have observed as many as five gene mutations, of which I am now concerned in investigation.



As shown in table III, the cells of the haploid epidermis and those of the P.M.C. undergo about 20–40 percent diminution in their long as

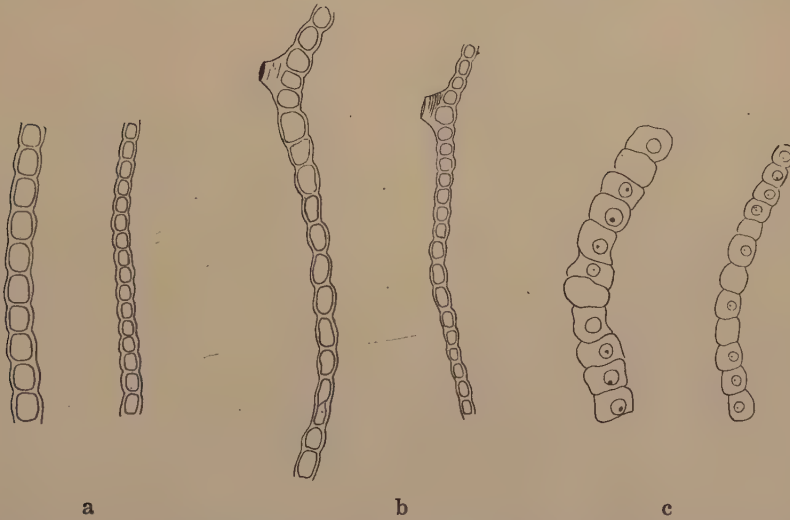


Fig. 1. Cells from epidermis of leaf (a), stem (b), and anther (c) of diploid (left) and haploid (right).

well as short axis compared with those of the corresponding tissues of the normal diploid. In the epidermal cells of the petal the diminution along the long axis is about half that along the short one, so they appeared to be somewhat narrower. Also in other parts the rate of reduction in length along the two axes is similar to the above. The number of P.M.C.'s in one locule of the haploid anther is also reduced. While in a locule of the diploid 20–25 P.M.C.'s are ordinarily found only 18–20 are seen in that of the haploid.

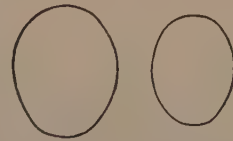


Fig. 2. P.M.C.'s of diploid (left) and haploid (right).

Examination of pollen grains has also revealed conspicuous abnormalities in both size and shape. Some are extremely small and shriveled, presenting no processes on their surface. A few others, although normal in appearance, are very large being almost  $1\frac{1}{2}$  times greater in diameter compared with those produced by the typical diploid. With the aid of a camera lucida under the ZEISS apochromatic objective 10 in combination with the compensating ocular K 20  $\times$ ,

diameters of about 450 pollen grains of both haploid and normal diploid

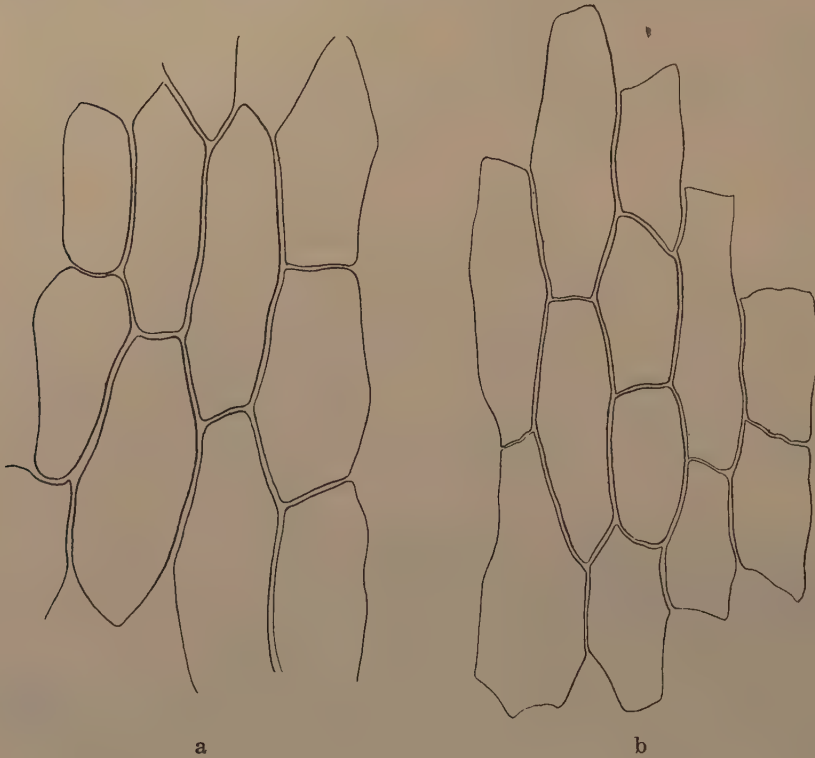


Fig. 3. Cells from petal epidermis of diploid (a) and haploid (b).

were drawn and measured in cm. The variation curve is given in fig. 4.

## VI. Cytology of the haploid

The haploid flower buds to be used for cytological preparations were removed from the grafted scions as well as from the original plant at various hours of the day between 8.30 A.M. and 5. P.M. While materials taken in the morning were found to provide mostly the figures of the prophase, the interkinesis and the second telophase, those taken in the afternoon, especially at the hours between 3 and 5 P.M. gave the active figures of division.

All the materials were killed with BOUIN's solution, imbedded in paraffin and cut into sections of about the thickness of  $25\mu$ . The smears were made according to YAMANOUCHI's schedule with iron-alum haematoxylin.

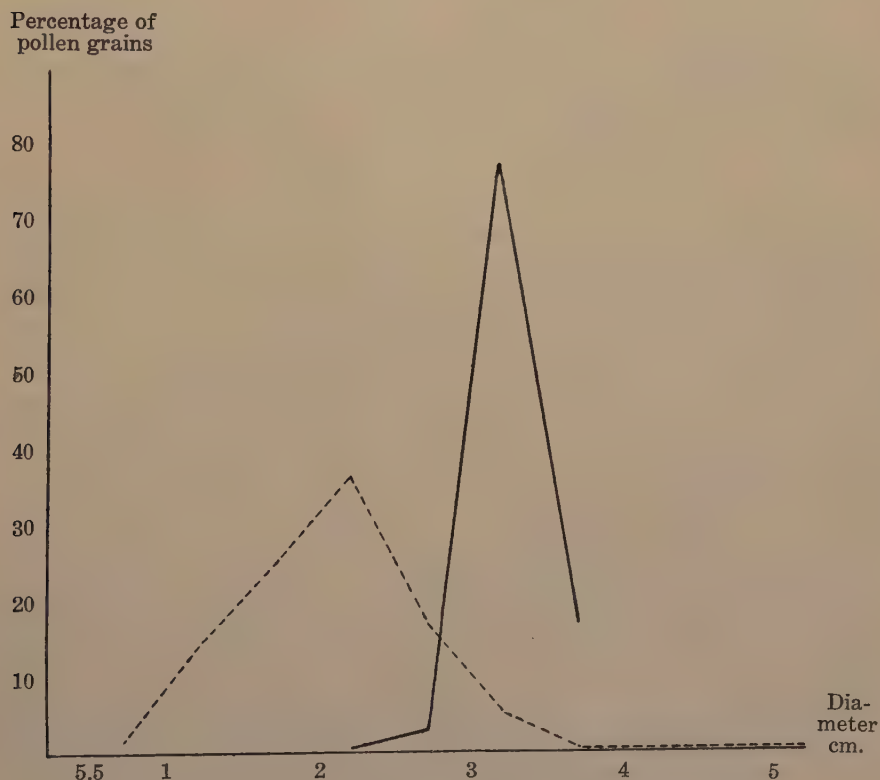


Fig. 4. Graphical representation of pollen size of both haploid (dotted line) and diploid (full line).

The figures of the division were studied on permanent preparations, but the temporary aceto-carmin method was frequently applied on examining the tetrads and pollen grains. In staining difficulties caused by unknown conditions were often encountered, and in such cases some of the preparations were restained, being retreated with the solution consisting of equal parts of saturated solution of picric acid and glacial acetic acid. Such restained preparations, although somewhat brownish, gave clear figures of the division.

On examining the smears no differences were noted in the mode of the division between the original plant and the grafted scions. They are as follows :

### 1. Observation on somatic chromosomes

No root tips were investigated, but the somatic chromosomes were observed very commonly in the epidermal cells of young petals. They were counted always as about 15 (fig. 5 a).

### 2. Observations on P. M. C.

At the outset it may be mentioned that early prophase stages are very difficult to be studied in this material, but the configurations found at stages before diakinesis show no particular differences compared with those of the corresponding stages of the diploid except that there is no doubleness in the spireme. At late strepsinema four two-nucleated pollen mother cells out of forty-eight in all were observed (fig. 5 b). At the stage corresponding to diakinesis in the diploids, the pairing of chromosomes, as would be expected, was not noted, but fifteen bomb-shaped univalents were found scattered around a nucleolus as shown in fig. 5 c. In two of the investigated mother cells there appeared also two nuclei undergoing the same stage (fig. 5 d). Undoubtedly they originated from the archesporial cells which had undergone karyokinesis but were unaccompanied by the following cytokinesis. This agrees with KARPECHENKO's observation on the *Raphanus-Brassica* hybrid (1917).

Spindle fibres now appear, but the chromosomes, instead of forming a distinct metaphase plate, remain scattered on the spindle (fig. 6 a). The proceeding of the chromosomes to opposite poles is observed to be quite irregular, and it differs widely in the individual pollen mother cells. The fifteen univalent chromosomes are separated in the assortments of 3 and 12, 4 and 11, 5 and 10, 6 and 9, 7 and 8 (fig. 6 b-6 e), the last three combinations being most commonly observed. But in many cases, the distribution of chromosomes to each pole is made more irregular by the occurrence of laggards and aberrants (fig. 6 f-6 j). They vary in number, so that in extreme cases more than seven chromosomes are scattered about the middle of the achromatic figure, and one to three may even be extruded into the cytoplasm, thus failing to be included in the daughter nuclei. It is not observed, however, as reported in other cases of haploid (tomato, LINDSTROM and



Koos 1930 ; *Oenothera*, DAVIS and KULKARNI 1930) that the entire group of 15 chromosomes has gone to a single pole, because here not a single monopolar spindle is noted. In one pollen mother cell about thirty

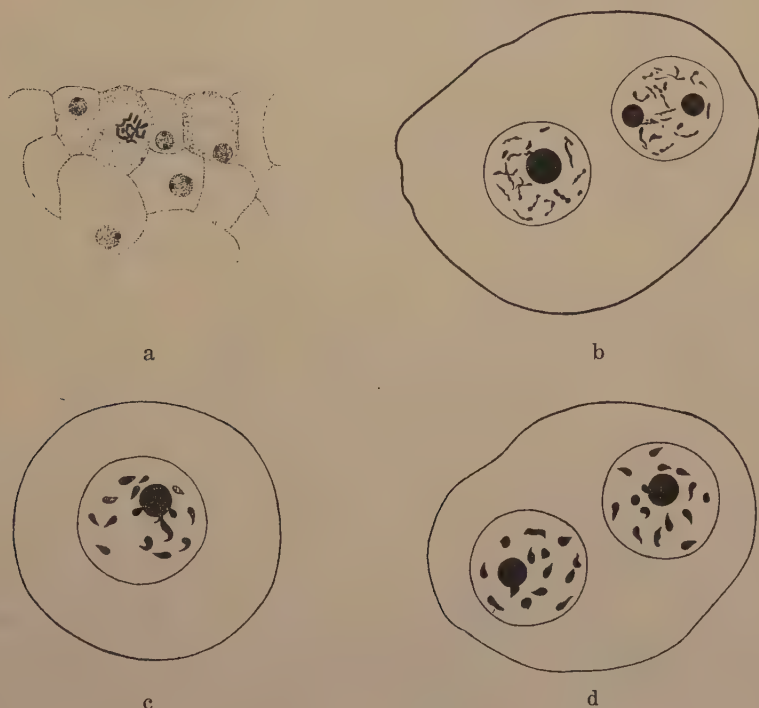


Fig. 5 a-d

- a. Metaphase of the somatic mitosis in an epidermal cell of petal.
- b. Two-nucleated P.M.C. undergoing strepsinema.
- c. Prophase corresponding to diakinesis. The 15 bomb-shaped univalents distinctly seen.
- d. Two-nucleated P.M.C. undergoing the stage corresponding to diakinesis.

chromosomes were observed proceeding to the opposite poles in a very irregular manner (fig. 6 k). It is probable that this is one to the splitting of the fifteen univalents or to two parallel spindles of the above-mentioned two-nucleated mother cells. However, the formation of no distinct metaphase plate and the very irregular way of the proceeding of chromosomes to each pole may suggest that it is due to the latter cause.

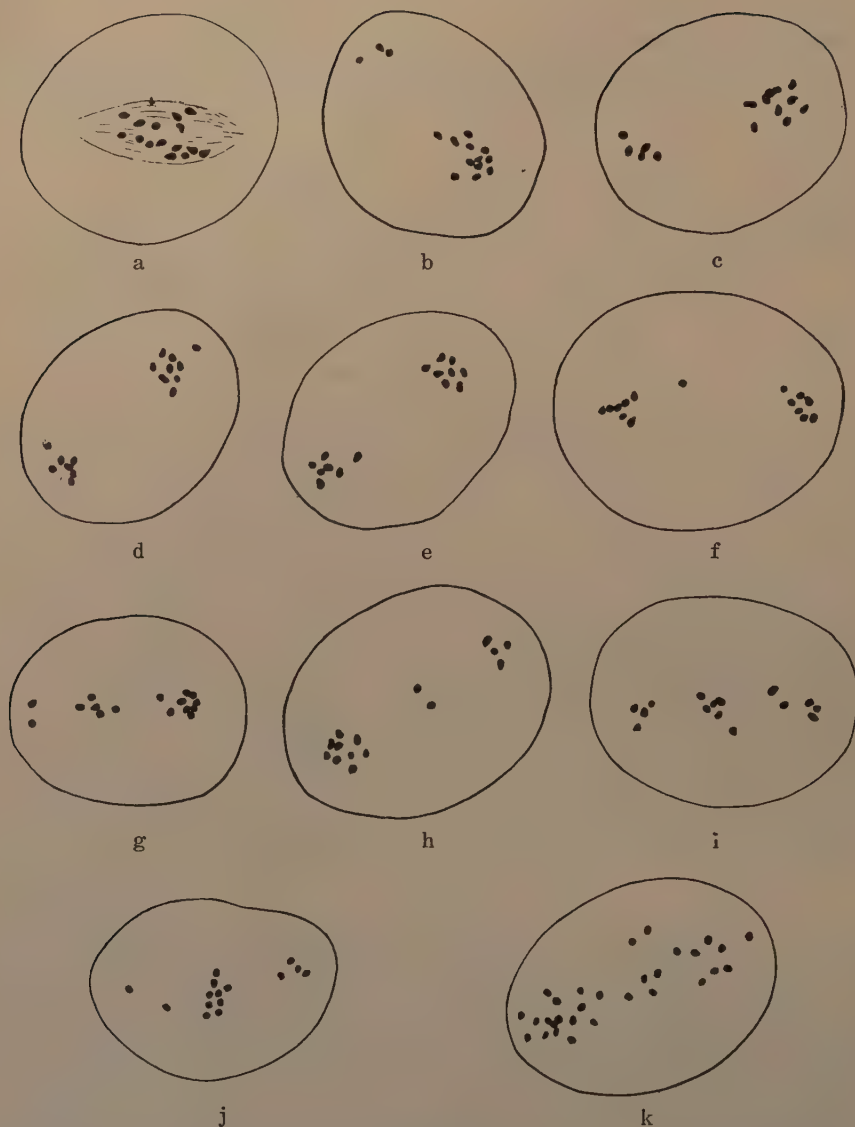


Fig. 6 a-j

- a. 15 chromosomes scattered over a spindle.
- b. Heterotypic anaphase; 3 chromosomes at one pole and 12 at the other.
- c. Heterotypic anaphase; 5 chromosomes at one pole and 10 at the other.
- d. Heterotypic anaphase; distribution of 15 chromosomes in the assortment of 6 and 9.
- e. Heterotypic anaphase; distribution of 15 chromosomes in the assortment of 7 and 8.
- f-j. Heterotypic anaphase showing varying numbers of laggards.
- k. Heterotypic anaphase; 30 chromosomes proceeding to the poles irregularly.

In the period corresponding to interkinesis of normal meiosis, two daughter nuclei are ordinarily formed in each mother cell, but those in which laggards and aberrants have occurred in the previous stage give one to three extra daughter nuclei of different size. The larger among them are almost equal in size or even larger than those found at opposite poles. Such nuclei are judged to be extra, simply on account of their position in the cytoplasm (fig. 7 c). No doubt they originated from groups of laggards which are relatively large in number. In the case where a nuclear membrane is formed about a group of laggards of smaller number or about each of the scattered aberrants, a minor extra

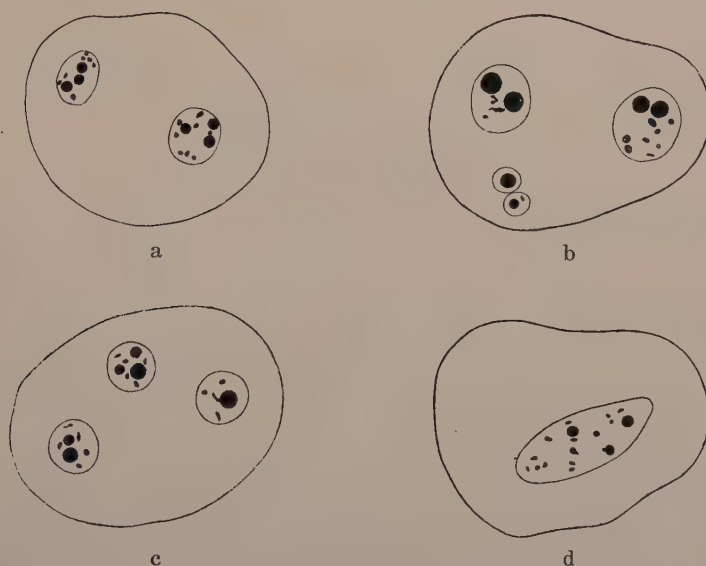


Fig. 7 a-d

- a. Stage corresponding to interkinesis.
- b-c. P.M.C.'s showing extra daughter nuclei.
- d. Formation of a restitution nucleus.

nucleus is formed (fig. 7 b). In rare instances a mother cell having only one large nucleus in its center is observed. Closer investigation reveals that it has, beside three nucleoli, fifteen countable prochromosomes scattered throughout the nuclear area. Such a restitution nucleus is supposed to have been organized by the formation of membrane about the 15 scattered univalents which did not reach the poles (fig. 7 d).

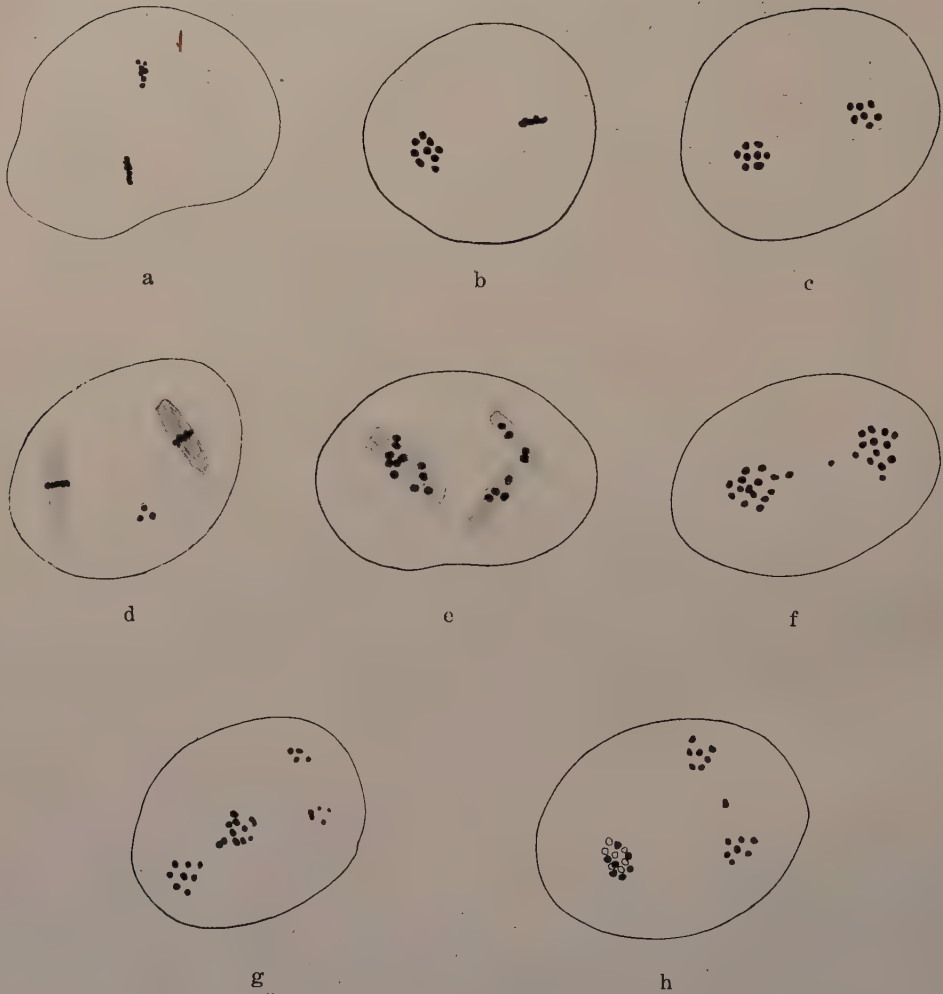


Fig. 8.

- a—c. Homotypic metaphase showing distinct daughter nuclear plates.  
 d. Homotypic metaphase; formation of 3 daughter nuclear plates.  
 e. Homotypic anaphase showing the formation of 3 spindles.  
 f. Homotypic anaphase; division of 15 chromosomes from a restitution nucleus.  
 g—h. Homotypic anaphase showing non-disjunction and lagging of a chromosome.



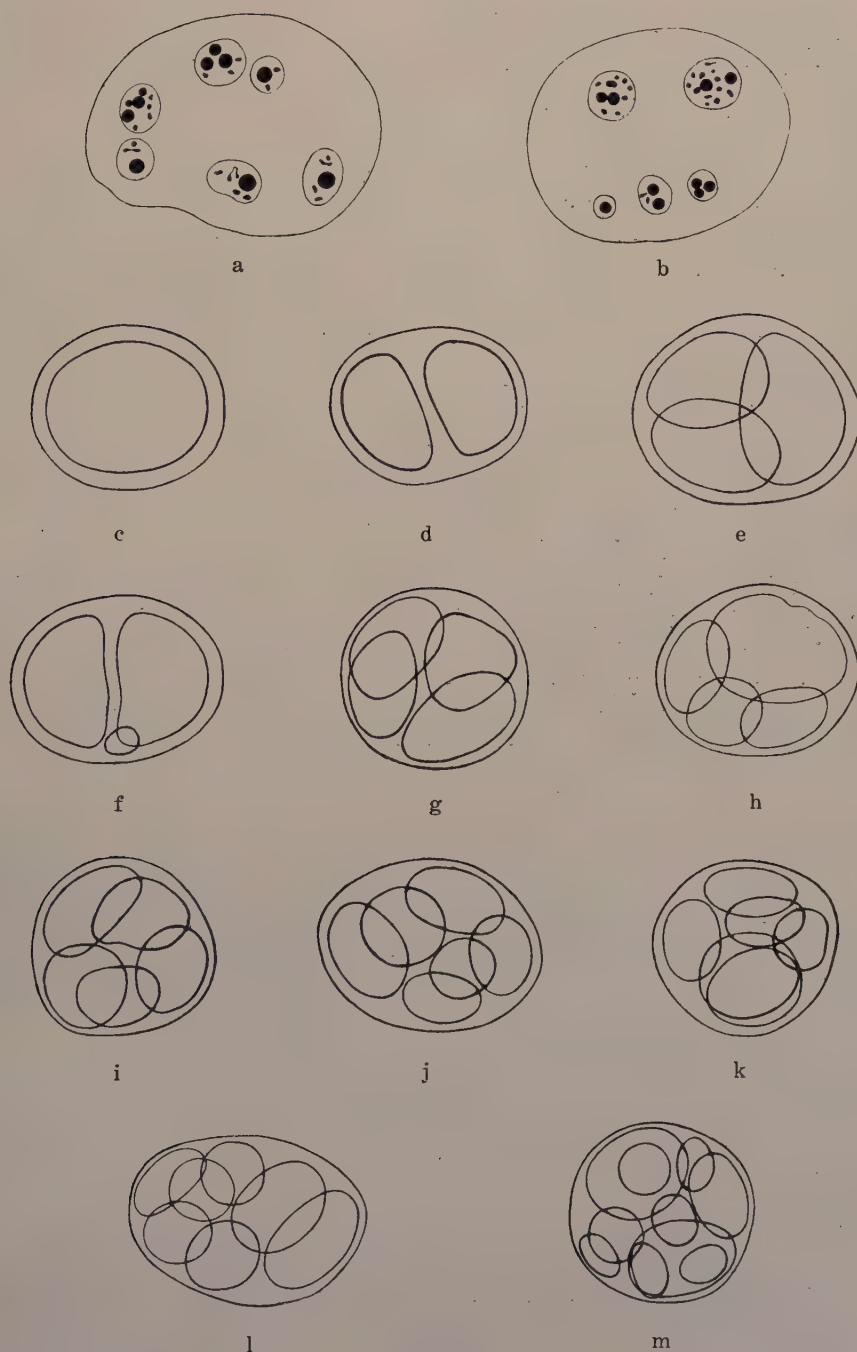


Fig. 9.

a—b. Telophase showing supernumerary nuclei.  
 c—m. Young pollen cells irregularly formed.

The irregularly distributed groups of chromosomes appear again in the second division, but at this time each forms a distinct metaphase plate in which all results of the segregation above-mentioned have been observed (fig. 8a-8c). The extra nuclei caused by the groups of laggards are also noted forming similar plates and there were frequently observed three spindles in one P.M.C. (fig. 8d, 8e.). But the extremely small nuclei which originated from individual aberrants are left unchanged in the cytoplasm. In anaphase these are separated, in most cases, quite normally, and the divided halves are distributed equally to the opposite poles. Although no metaphase plate formed by the whole group of 15 chromosomes from the restitution nucleus was observed two of the investigated P.M.C.'s in this stage showed clearly each separated set of fifteen chromosomes moving towards the poles (fig. 8f).

Here also we have noted some irregular modes of division. Likewise in the first anaphase, the occurrence of laggards is not uncommon and it gives rise to another extra nucleus. Further, non-disjunction is found frequently as shown in fig. 8g-h.

In telophase the above-mentioned irregular mitosis results in the formation of supernumerary nuclei. Accordingly in the following cytokinesis there are produced, instead of the usual tetrad of four equal cells, groups of 2 to 7 cells of various shapes and sizes. Besides monads with double haploid sets of thirty chromosomes were also discovered. In extreme cases a group of 11 cells is included in one mother cell.

## VII. Discussion

As thoroughly discussed by KUHN (1930) the origin of haploid in plants can take place in three ways, viz., parthenogenesis, gynogenesis, and androgenesis. In the case where a metromorphic haploid is obtained in  $F_1$  progeny of a cross, there is no question that the haploid originates from one of the reduced cells in embryo-sac. In most cases it is natural and appropriate to consider that it is produced through the apomictic development of a haploid egg. Then parthenogenesis and gynogenesis are to be considered. And this is the case with the haploids in

- Triticum compactum* . . . . . (*T. compactum* × *Aegilops cylindrica*, GAINS and AASE 1926),  
*Datura Stramonium* . . . . . (*D. Stramonium* × *D. ferox*, BELLING and BLAKESLEE 1927),

- Nicotiana tabacum* . . . . . (*N. tabacum* × 12-chromosomic *Nicotiana* species, RUTTLE 1928),  
*Solanum nigrum* . . . . . (*S. nigrum* × *S. luteum*, JØRGENSEN 1928),  
*Crepis capillaris* . . . . . (*C. capillaris* × *C. tectorum*, HOLLINGSBED 1928. *C. capillaris* × *C. neglecta*, BABCOCK and NAWASHIN 1930),  
*Oenothera Hookeri* . . . . . (*Oe. Hookeri* × *Oe. longiflora*, *Oe. Hookeri* × *Oe. argillicola*, STOMPS 1929),  
*Oe. franciscana*. . . . . (*Oe. franciscana* × *Oe. franciscana sulfurea*, St. H. EMERSON 1929, DAVIS and KULKARNI 1930),  
*Oe. rubricalyx* . . . . . (*Oe. rubricalyx* × *Oe. eriensis*, GATES 1929),  
*Oryza sativa* . . . . . (intra-specific cross of Dekiyama × Bunketutô, MORINAGA and FUKUSHIMA 1931).

However, when a haploid comes out by selfing of a pure line or in  $F_2$  generation of a cross, be it intra- or inter-specific, androgenesis may be taken into consideration besides the above-mentioned possibility. Following are the cases in which this interpretation may be applied.

#### In pure lines :

- Datura Stramonium* . . . . . (BLAKESLEE and others, 1922, 1927)  
*Solanum nigrum* . . . . . (JØRGENSEN 1928)  
*Nicotiana glutinosa* . . . . . (GOODSPEED and AVERY 1929)  
*Oenothera franciscana* . . . . . (DAVIS and KULKARNI 1930)

#### In $F_2$ generations of crosses :

- Lycopersicum esculentum* . . . . . (LINDSTROM 1929)  
*Matthiola incana*. . . . . (LESLEY and FROST 1928)

But in selfing of pure lines or in completely fertile intraspecific crosses, it is somewhat unreasonable to consider the possibility of androgenesis, because the existence of alternative sterility (= wechselseitige Sterilität of KUHN) between gametes in the same species can not easily be approved. If so, in the named case a haploid must come out through parthenogenesis or gynogenesis. Only in a case where a patromorphic haploid appears in  $F_1$  generation of a cross, an androgenetic development of a sperm-nucleus can be approved. One may find two such instances in haploid *Tabacum* reported by CLAUSEN and LAMMERTS (1929) and by KOSTOFF (1929).

In discussing the origin of the haploid *Pharbitis*, the fact that it has come out in  $F_1$  generation showing the recessive traits characteristic

of its female parent strongly suggests that it has originated from a haploid egg of its mother. Moreover, since any sort of apomictic development of an egg can not be observed in *Pharbitis Nil*, it is positively sure that it has been caused by the stimulus of pollen, either parthenogenetically or gynogenetically. Then it may be asked what circumstances have brought out such a peculiar phenomenon. Firstly, an unfavourable environmental conditions such as an extreme cold as in the case of *Datura* and *Crepis*, comes into question. However, our crossing operations in which the haploid originated have been done early in September, the most favourable period to fertilization of morning glory, so the existence of any extreme conditions is out of question. Moreover, the appearance of haploid in two successive years strongly denies the idea that it came out through the action of a certain extreme condition particular for that year, because the repetition of similar extreme condition in two consecutive years is difficult to be conceived.

Though in this respect I could not attain to a very definite conclusion, the following hypothesis may be suggested. In the variety 'Pine Inconstant' of which the genotypic constitution is  $a'a'$ , pollen grains are largely abortive. On the contrary, in the 'Primary Intermediate Form' which, as before stated, is a periclinal chimera composed of  $a'a'$  covered by the epidermis  $Aa'$ , the pollen grains are in high degree functional, if not completely, notwithstanding the fact that it is  $a'a'$  in its interior. The conclusive interpretation of the fact should depend upon further studies, but it can, perhaps, be attributed to some physiological influences of the epidermis. However, these pollen grains are extremely various in size. It is not impossible that correspondingly they are very various in their physiological activities, and it may further be assumed that some of them are weaker in their function than the normal ones. May it be not impossible that such weak ones act so as to stimulate eggs to parthenogenic developments, so as to give rise to the haploids?

The haploid which has appeared in the  $F_2$  progeny of the 'Snowflake' variety of *Matthiola incana* (LESLEY and FROST 1928) may perhaps be interpreted in the same way as a result of stimulus caused by a pollen which might be produced by the irregular meiosis of the aberrant having an extra chromosome.

It should be noted that the haploid has appeared twice in two successive years in almost the same frequency of 1:300, which is considerably higher than that in *Oenothera*. It may be added that in this year (1932) we have obtained again two extremely small recessive



seedlings among about 700  $F_1$  progenies of the same cross, though unfortunately they died away before being verified to be haploids.

### VIII. Summary

(1) The reappearance of the haploid Japanese morning glory in the  $F_1$  generation of the varietal cross, Normal  $\times$  'Pine Inconstant,' is noted.

(2) The plant is considerably reduced in size in all its parts with various morphological characteristics. Pollen grains produced on it show a great variability in size, and a high degree of abortion is seen as the result of the irregular meiosis.

(3) The haploid was completely sterile, but asexually propagated by grafting its shoots on sweet potato. The grafted scions grew vigorously, and were preserved much longer than the mother stock itself.

(4) Measurements of cell size in epidermis of stem, leaf, and corolla and of P.M.C. in comparison with those of the normal diploid show about 20–40 percent diminution. The P.M.C.'s found in a locule of the haploid anther are also reduced in number.

(5) A bud mutation has been observed in one of its shoots, but it has been different in its nature from that which has occurred in a shoot of the haploid formerly obtained.

(6) Detailed description of various irregular features of meiosis as well as of 15 somatic chromosomes has been made. Two-nucleated P.M.C.'s were observed several times.

(7) The origin of the haploid is discussed to the effect that it can perhaps be due to an apomictic development of an egg caused by the particular pollen grain of the male parent.

(8) The haploid seems to appear in a very high frequency of 1:300 in this cross.

---

## Literature cited

- BLAKESLEE, A. F., BELLING, J., FARNHAM, M. E. and BERGNER, A. D. (1922). A haploid mutant in the Jimson weed, *Datura Stramonium*. *Science*, **55**, 646-7.
- BLAKESLEE, A. F., MORRISON, G. AVERY, A. G. (1927). Mutation in a haploid *Datura*. *Journ. Heredity*, **18**, 193-9.
- CLAUSEN, R. E. and LAMMERTS, W. E. (1927). Interspecific hybridization in *Nicotiana*. X. Haploid and diploid merogony. *Amer. Nat.* **63**, 279-82.
- DAVIS, B. M. and KULKARNI, C. G. (1930). The cytology and genetics of a haploid sport from *Oenothera franciscana*. *Genetics*, **15**, 55-80.
- GAINES, E. F. and AASE, HANNAH C. (1926). A haploid wheat plant. *Amer. Journ. Bot.* **13**, 373-85.
- GATES, R. R. and GOODWIN, K. M. A new haploid *Oenothera*, with some considerations on haploidy in plants and animals. *Journ. Gen.* **23**, 123-156.
- GOODSPEED, T. H. and AVERY, P. (1929). The occurrence of a *Nicotiana glutinosa* haplont. *Proc. Nat. Acad. Sci.* **15**, 502-4.
- HOLLINGSHEAD, Lillian (1928). A preliminary note on the occurrence of haploids in *Crepis*. *Amer. Nat.* **62**, 282-4.
- JØRGENSEN, C. A. (1928). The experimental formation of heteroploid plants in the genus *Solanum*. *Journ. Gen.* **19**, 133-211.
- KARPECHENKO, G. D. (1927). The production of polyploid gametes in hybrids. *Hereditas*, **9**, 349-68.
- KOSTOFF, D. (1929). An androgenic *Nicotiana* haploid. *Zeits. f. Zellforsch.* **9**, 640-2.
- KUHN, E. (1930). Pseudogamie und Androgenesis bei Pflanzen. *Der Züchter*, **II**, 124-36.
- LESLEY, M. M. and FROST, H. B. (1928). Two extreme small *Matthiola* plants: a haploid with one and a diploid with two additional chromosome fragments. *Amer. Nat.* **62**, 22-33.
- LINDSTROM, E. W. (1929). A haploid mutant in the tomato. *Journ. Heredity*, **20**, 23-30.
- LINDSTROM, E. W. and KOOS, K. (1931). Cyto-genetic investigation of a haploid tomato and its diploid and tetraploid progeny. *Amer. Journ. Bot.* **18**, 398-410.
- MORINAGA, T. and FUKUSHIMA, E. (1931). Preliminary report on the haploid plant of rice, *Oryza sativa* L. *Proc. Imp. Acad.* **7**, No. 10. 333-4.
- U, N. (1930). On the appearance of a haploid in the Japanese morning glory, *Pharbitis Nil*, CHOIS. (Japanese). *Jap. Journ. Gen.* **6**, 203-4.
- U, N. (1930). On the regular mutation of a variety 'Pine Inconstant' in *Pharbitis Nil*, CHOIS. (Japanese) *Jap. Journ. Gen.* **6**, 199-202.
-

### Explanation of plates V-IX

#### PLATE V

- Fig. 1. Normal recessive variety (female parent).  
Fig. 2. The haploid.

#### PLATE VI

- Fig. 3. The haploid at its earlier stage of growth (2 weeks after its germination).  
Fig. 4. Corolla of the female parent.  
Fig. 5. Corolla of the haploid.  
Fig. 6. Leaf of the female parent.  
Fig. 7. Leaf of the haploid.

#### PLATE VII

- Fig. 8. The haploid at its adult stage.

#### PLATE VIII

- Fig. 9. Haploid scion grafted on sweet potato.  
Fig. 10. A haploid shoot undergoing mutation.

#### PLATE IX

- Fig. 11. 'Pine Inconstant.'  
Fig. 12. Typical corolla characteristic of 'Pine Inconstant'.  
Fig. 13. Corolla borne on its chimeral part.  
Fig. 14. 'Pine Inconstant' forming a periclinal chimera, the 'Primary Intermediate Form' (male parent).





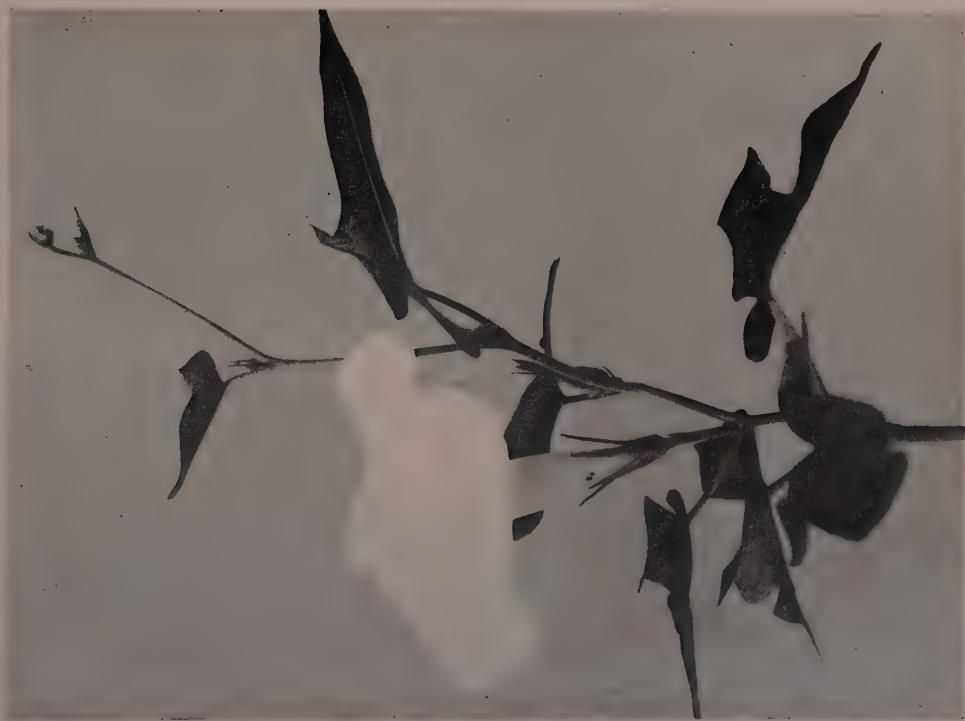


Fig. 1



Fig. 2



Fig. 6



Fig. 7

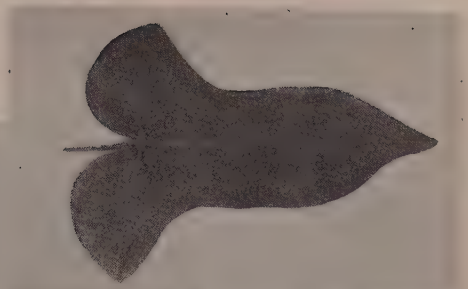


Fig. 3



Fig. 5



Fig. 4







PLATE VII



Fig. 8





Fig. 9



Fig. 10





PLATE IX

Fig. 12.



Fig. 14

Fig. 13



Fig. 11





# The genetics and cytology of certain cereals

By I. NISHIYAMA

## III. Different compatibility in reciprocal crosses of *Avena*, with special reference to tetraploid hybrids between hexaploid and diploid species<sup>(1)</sup>

By Hitoshi KIHARA and Ichizo NISHIYAMA

---

With plates X-XI and 51 text-figures

---

(Received June 6, 1932)

### Contents

	Page
INTRODUCTION . . . . .	246
Part I. CROSSING EXPERIMENTS . . . . .	248
(a) Interspecific crosses in <i>Avena</i> . . . . .	248
(b) Tetraploid hybrids $F_1$ . . . . .	251
1. Fertility of tetraploid hybrids . . . . .	251
2. Meiosis in tetraploid hybrids . . . . .	252
Part II. EMBRYOLOGICAL STUDIES . . . . .	260
1. <i>A. strigosa</i> SCHREB. and <i>A. fatua</i> L. . . . .	260
2. <i>A. strigosa</i> SCHREB. ( $\varphi$ ) $\times$ <i>A. fatua</i> L. ( $\sigma$ ) . . . . .	262
3. <i>A. fatua</i> L. ( $\varphi$ ) $\times$ <i>A. strigosa</i> SCHREB. ( $\sigma$ ) . . . . .	266
4. Unfertilized ovules and abnormal formation of the embryo . . . . .	272
DISCUSSION . . . . .	274
Different compatibility in reciprocal crosses . . . . .	274
Autopolyploid . . . . .	282
Allopolyploid . . . . .	286
SUMMARY . . . . .	300
LITERATURE CITED . . . . .	302

---

(1) Contributions from the Laboratory of Genetics, Biological Institute, Kyôto Imperial University, No. 26.

## Introduction

It is well known that in the genus *Avena* there are 3 different karyological groups having 7, 14, and 21 haploid chromosomes respectively. Interspecific  $F_1$  hybrids were easily obtained between any two species in the same group, while the crosses between 7- and 14-chromosome plants, as well as between 14- and 21-chromosome plants, were more or less difficult (EMME 1929, NISHIYAMA 1929). The crossing experiment was often undertaken between 7- and 21-chromosome plants but nobody has ever succeeded in getting the hybrids so far as we are aware. NISHIYAMA (1929) also attempted the same crossing during the two years 1927–1928, but no viable seeds were obtained. In 1929–1931, the authors obtained successfully many tetraploid hybrids only in one direction of the cross, namely  $21-(\varnothing) \times 7$ -chromosome plants ( $\sigma$ ). It is therefore proved that  $F_1$  hybrids can be produced among 3 different groups in *Avena* by artificial crossing.

There was a great difference in getting good seeds owing to the difference of parents used and also to the direction of the cross. The difference was most conspicuous in the reciprocal crosses between diploid and hexaploid species. The shrivelled grains, which contain embryos and never germinate, are obtained more numerous in the cross  $2n(\varnothing) \times 6n(\sigma)$  than in the reciprocal cross, where seldom good and a few wrinkled grains are produced. This shows that fertilization may occur more easily in this direction of cross [ $2n(\varnothing) \times 6n(\sigma)$ ] than in the reciprocal direction [ $6n(\varnothing) \times 2n(\sigma)$ ]. This conclusion is quite in accordance with WAKAKUWA's experiments of *Triticum*-species (WAKAKUWA 1930).

KIHARA (1932) has also made crossing experiments in wheat. He mixed approximately the same amount of pollen grains of *Triticum durum* and *T. vulgare*. The mixed pollen grains were dusted on the stigma of *T. durum* or *T. vulgare*. In the first case he obtained about an equal number of bastards (pentaploid hybrid) and non-bastards (*T. durum*). In the second case, however, the number of bastards was about  $\frac{1}{10}$  of the non-bastards (*T. vulgare*). This result shows clearly that the pollen grains with a higher chromosome number can germinate very well on the stigma with a lower chromosome number and very easily fertilize the egg cell.

WAKAKUWA's germination tests of hybrid-seeds, however, revealed the interesting fact that the germination was good when the female has



more chromosomes, and bad in the reciprocal cross. The success of the cross will, therefore, be shown by the product of the percentage of setting seeds and the percentage of the germination of the seeds. The products were always large when the mother plant has a higher chromosome number.

In the crossing experiments of WATKINS (1927), THOMPSON and CAMERON (1928), and THOMPSON (1930a) with *Triticum*-species, the crosses were also always more successful when the female had more chromosomes than the male. For instance, WATKINS (1927) found in pentaploid *Triticum* hybrids that the  $F_1$  kernels were consistently normal in size but wrinkled if the 14-chromosome plant was used as female parent, whereas the kernels were plump and small in size if the plant used was male. The germination of the plump kernels was much better than the wrinkled ones. If 3 genomes of dinkel wheat ( $n = 21$ ) are represented by A, B and  $D^{(1)}$ , which have 7 chromosomes respectively and those of emmer wheat by AB, dinkel ( $\varnothing$ )  $\times$  emmer ( $\sigma$ ) will give an endo-

sperm of the composition  $\begin{cases} ABD \\ ABD \\ AB \end{cases}$ , because 2 sets of ABD come from the polar nuclei and the remaining AB from the male nucleus. On the other hand, the reciprocal hybrid obtains 2 sets of AB from the polar nuclei and 1 set, ABD, from the male nucleus, so that the formula is

shown as  $\begin{cases} ABD \\ AB. \\ AB \end{cases}$ . In the former the endosperm development is more or

less weak and in the latter remarkably abnormal. The poor development of the endosperm is always associated with the deficiency of the *D* genom, and the more the deficiency of the genom, the weaker the development (WATKINS 1927). WATKINS further considered that the poor development might not be caused through the deficiency itself but by the numerical proportion of genomes between the endosperm and embryo.

In *Datura* (BLAKESLEE, BELLING and FARNHAM 1923, BUCHHOLZ and BLAKESLEE 1929), *Nicotiana* (CHRISTOFF 1928, EAST 1928 and KOSTOFF 1930) and *Galeopsis* (MÜNTZING 1930 a, b), the pollination, on the contrary, usually was successful only when the female plant had more chromosomes than the male. In intergeneric hybridizations such as *Aegilops*  $\times$  *Triticum* (LEIGHTY, SANDO and TAYLOR 1926, PERCIVAL 1926 and KATAYAMA 1931) the direction of the cross also seems to play an important role for the success of crossing, even if the chromosome number of the parents is equal.

(1) KIHARA (1924) called a genom special for dinkel group D.

After these results given above, we could hardly give a general rule to account for the difference in success of the reciprocal crossings. The problem is very complicated and requires further investigations. Above all we have no embryological studies on the development of bastard-embryo and endosperm. The chief subject of the present work is to make clear two points: (1), the difference in effective pollination in reciprocal crosses, and (2), the difference in development of the embryo and endosperm after fertilization. The maturation division of PMC of the tetraploid hybrids is also, incidentally, given, where the behavior of the univalent and bivalent chromosomes is described. The genom-analytical consideration and morphology of the hybrids, however, are not given here.

In the discussion of the present work, the available data were taken into consideration and we have considered the success of crossing from two points,—pollen tube growth and the development of the embryo and endosperm.

The species used in the present study are the same as those used in previous experiments (KIHARA 1919, 1924, and NISHIYAMA 1929) and also some other species which were recently sent to the writers from foreign countries.<sup>(1)</sup> All plants were grown under natural conditions in the experimental field. The crossing experiment was made by the same method as in the previous study (NISHIYAMA 1929). Fixed material was always used for the cytological observation.

## Part 1. Crossing experiments

### a) INTERSPECIFIC CROSSES IN *Avena*

EMME (1929) reported the result of crosses between 14- and 21-chromosome species in *Avena*; the setting of seeds was very bad, 2.9% in average. NISHIYAMA (1929) made artificial hybrids among many species with the same or different chromosome numbers. But only in the combination, 7- $\times$ 21-chromosome species, he was unable to obtain  $F_1$  kernels which could germinate.

During the 3 succeeding years, 1929–1931, the writers made many interspecific crossings.  $F_1$  kernels obtained were sown in a cool green house and the percentage of germinated kernels were examined. The results are summarized in table 1.

---

(1) We take the opportunity to express our thanks to Prof. Dr. S. Ito, Director of the Botanical Garden, Hokkaido Imperial University, for his kindness in providing the material.

TABLE 1

Results of crossing and kernel germination.

Cross	No. of flowers pollinated	No. of kernels obtained	%	No. of kernels sown	No. of kernels germinated	%
<b>♀ 7 × 7 ♂</b>						
<i>A. strigosa</i> (self)	13	12	92.31	12	12	100.00
<i>A. strigosa</i> × <i>A. Wiestii</i>	11	9	81.82	9	9	100.00
<i>A. Wiestii</i> × <i>A. strigosa</i>	33	11	33.33	11	11	100.00
<i>A. strigosa</i> × <i>A. nudabrevis</i>	9	8	88.89	8	8	100.00
<i>A. Wiestii</i> × <i>A. nudabrevis</i>	9	4	44.44	4	4	100.00
<b>14 × 14</b>						
<i>A. abyssinica</i> × <i>A. barbata</i>	11	5	45.45	5	5	100.00
Reciprocal	13	9	69.23	9	9	100.00
<b>21 × 21</b>						
<i>A. sativa</i> × <i>A. fatua</i>	11	11	100.00	5	5	100.00
<i>A. sterilis</i> × <i>A. fatua</i>	16	12	75.00	5	5	100.00
<b>7 × 14</b>						
<i>A. strigosa</i> × <i>A. barbata</i>	50	43	86.00	43	0	0.00
Reciprocal	118	38	32.20	38	32	84.21
<i>A. hirtula</i> × <i>A. barbata</i>	15	9	60.00	9	0	0.00
Reciprocal	37	12	32.43	4	4	100.00
<i>A. strigosa</i> × <i>A. abyssinica</i>	12	8	66.67	8	0	0.00
Reciprocal	62	11	17.74	11	8	72.73
<i>A. abyssinica</i> × <i>A. hirtula</i>	29	9	31.03	9	9	100.00
<i>A. Wiestii</i> × <i>A. barbata</i>	24	8	33.33	8	0	0.00
Reciprocal	98	29	29.59	26	20	76.92
<i>A. Wiestii</i> × <i>A. abyssinica</i>	42	22	52.38	19	0	0.00
Reciprocal	95	37	38.95	—	—	—
<b>7 × 21</b>						
<i>A. strigosa</i> × <i>A. fatua</i>	166	125	75.30	125	0	0.00
Reciprocal	134	37	27.61	30	22	73.33
<i>A. strigosa</i> × <i>A. sativa</i>	131	103	78.63	100	0	0.00
Reciprocal	77	2	2.60	2	1	50.00
<i>A. strigosa</i> × <i>A. sterilis</i>	24	21	87.50	21	0	0.00
Reciprocal	11	0	0.00	—	—	—
<i>A. Wiestii</i> × <i>A. sativa</i>	51	24	47.06	8	0	0.00
<b>14 × 21</b>						
<i>A. barbata</i> × <i>A. fatua</i>	87	22	25.29	17	16	94.12
Reciprocal	34	8	23.53	8	5	62.50
<i>A. barbata</i> × <i>A. sativa</i>	29	15	51.72	15	11	73.33
Reciprocal	23	7	30.43	7	7	100.00
<i>A. barbata</i> × <i>A. sterilis</i>	13	8	61.54	8	8	100.00
Reciprocal	9	1	11.11	1	1	100.00
<i>A. abyssinica</i> × <i>A. sativa</i>	24	7	29.17	7	7	100.00
<i>A. abyssinica</i> × <i>A. sterilis</i>	13	7	53.85	4	4	100.00

To find out the technical difficulties of artificial crossing we pollinated the stigma of *A. strigosa* emasculated with fresh pollens of the same species and obtained well developed kernels at 92.31%. Cross pollinations between 7-chromosome species showed a success of over 81%, with two exceptions where the number of kernels was remarkably decreased, when *A. Wiestii* was used as mother plant. *A. barbata* ( $n = 14$ )  $\times$  *abyssinica* ( $n = 14$ ) gave readily hybrid kernels but in rather low proportion. In this case the setting of seeds might be much affected by the crossing technique. Both species usually bloomed at 8–10 P.M. in Kyôto, but the pollination was taken place about 3–4 hours before anthesis. Therefore, the anther was too young and hardly dehisced. In other cases the pollination was made immediately before anthesis and we could obtain many anthers spreading abundant ripe pollens. From table 1 it also may be seen that interspecific hybrids were easily obtained between 21-chromosome species.

In the above mentioned crosses ( $7 \times 7$ ,  $14 \times 14$  and  $21 \times 21$ ),  $F_1$  kernels always presented about the same appearance as those of the mother plants. Their germination was as good as 100% in all of these crosses.

In the cross 7- ( $\varnothing$ )  $\times$  14-chromosome species ( $\sigma$ ) many seeds are obtained. But we have not yet obtained any kernels which are able to germinate. When stigmas are pollinated, ovaries grow as large as those of the mother plant selfed. Hybrid kernels, however, contain only watery substances and at maturity they consist practically of the empty pericarp, the endosperm and embryo having been partially or completely degenerated. All of the kernels are very shrivelled and do not germinate at all. Reciprocal crosses gave small kernels at a low percentage. They were, however, plump and germinated very well. In the tetraploid hybrid 7- ( $\varnothing$ )  $\times$  21-chromosome species ( $\sigma$ ) crossing experiments gave the same results as the above stated triploid hybrid 7 ( $\varnothing$ )  $\times$  14 ( $\sigma$ ). In the reciprocal cross a few viable kernels were produced.  $F_1$  kernels from *A. fatua* ( $\varnothing$ )  $\times$  *strigosa* ( $\sigma$ ) were markedly small and flat. It was sometimes difficult to distinguish them from unfertilized ovaries. The cross *A. sativa* ( $\varnothing$ )  $\times$  *strigosa* ( $\sigma$ ) gave only one kernel which was normal in size but was somewhat wrinkled.

In pentaploid *Avena* hybrids more kernels were obtained when the 14-chromosome species was female than when it was male. All  $F_1$  kernels were almost normal in appearance and showed good germination, independent of the direction of the cross. From table 1 it may be noted that the amount of kernels set is always reduced when *A. Wiestii* is the mother plant. Fig. 1 shows parental and hybrid





Fig. 1

1. Kernels of *A. strigosa* SCHREB. 2. Kernels of *A. barbata* POTT.  
 3. Kernels of *A. sativa* L. 4. Kernels of *A. fatua* L. 1x2. F<sub>1</sub> kernels  
 of *A. strigosa* (♀) × *barbata* (♂). 2x1. F<sub>1</sub> kernels of the reciprocal.  
 2x3. F<sub>1</sub> kernels of *A. barbata* (♀) × *sativa* (♂). 3x2. F<sub>1</sub> kernels of the  
 reciprocal. 1x3. F<sub>1</sub> kernels of *A. strigosa* (♀) × *sativa* (♂). 3x1. F<sub>1</sub>  
 kernel of the reciprocal. 1x4. F<sub>1</sub> kernels of *A. strigosa* (♀) × *fatua* (♂).  
 4x1. F<sub>1</sub> kernels of the reciprocal.

kernels in all possible crosses between species with different chromosome numbers.

#### b) TETRAPLOID HYBRIDS F<sub>1</sub>

##### 1. Fertility of tetraploid hybrids

All F<sub>1</sub> hybrids grew normally. The height of the plant was longer than that of either parents in the hybrid *A. fatua* (♀) × *strigosa* (♂), but was clearly intermediate when *A. sativa* was used instead of *A. fatua*. The anthesis appeared to be normal but no anther generally dehisced. These hybrids, therefore, were completely sterile by selfing. Karyological studies, which will be later stated, show that these hybrids may be highly sterile. A few kernels were obtained from unprotected

panicles when a parent *A. fatua* grew in their neighbourhood (table 2). From these facts it can be seen that at least some female gametes are functional. But we can not positively say that all male gametes are functionless, because they are enclosed in the undehisced anther loculus, when most of the pollen grains are abortive.

TABLE 2  
Fertility of  $F_1$  hybrids.

	No. of panicles examined	No. of florets	No. of kernels
<i>A. sativa</i> $\times$ <i>strigosa</i> $F_1$ (selfed)	8	1324	0
<i>A. fatua</i> $\times$ <i>strigosa</i> $F_1$ (selfed)	12	2572	0
„ (unprotected)	4	575	7 (1.22%)

## 2. Meiosis in tetraploid hybrids

Meiotic divisions were observed in PMC of two  $F_1$  hybrids, *A. sativa* and *A. fatua* ( $\varnothing$ )  $\times$  *strigosa* ( $\sigma$ ). Chromosome behaviors appeared to be quite similar in both hybrids. Bivalent and univalent chromosomes were always observed in the metaphase of the first maturation division of PMC. Besides, chromosome complexes consisting of 3 or more elements could be sometimes found very clearly as shown in figs. 2-13. The somatic number of chromosomes, which was calculated from the heterotypic metaphase of PMC, corresponds to the sum of the haploid chromosome number of the parents.

Chromosome pairings are generally loose and their number is also variable. Statistical counts of the number of bivalents and chromosome complexes were made in the metaphase of the first maturation division in PMC. The results are given in table 3. The horizontal column shows the number of bivalents. The trivalent chromosome is treated here as bivalent and the tetravalent as well as pentavalent as two bivalents, etc. The vertical column gives only the number of chromosome complexes (trivalents, tetravalents etc.) found in one PMC.

In *A. sativa*  $\times$  *strigosa*, two materials which were fixed in different periods were used for this purpose. Table 3a shows the result obtained from the material taken at noon on a warm day, and table 3b represents that from PMC fixed on a cold morning. In these results we can see

TABLE 3

Frequency of PMC with bivalents and chromosome complexes.

a. *A. sativa*  $\times$  *strigosa*. Count was made in PMC fixed on a warm midday. (1930)

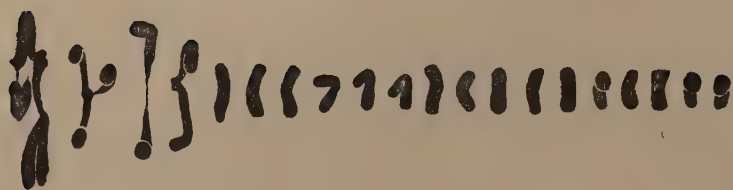
	No. of bivalents							Total
	3	4	5	6	7	8	9	
No. of chrom. complexes								
0				6	10	2		18
1	4	3	7	8	12	4	1	39
2		3	8	9	6	5	1	32
3			4		4			8
4			1	1	1			3
Total	4	6	20	24	33	11	2	100

b. *A. sativa*  $\times$  *strigosa*. Count was made in PMC fixed on a cold morning. (1930)

	No. of bivalents							Total
	3	4	5	6	7	8	9	
No. of chrom. complexes								
0	1	2	5		7			15
1		2	1	11	13	5		32
2		3	1	12	12	4	2	34
3		2	3	2	6	3		16
4				2	1			3
Total	1	9	10	27	39	12	2	100

c. *A. fatua*  $\times$  *strigosa*. (1930 and 1931)

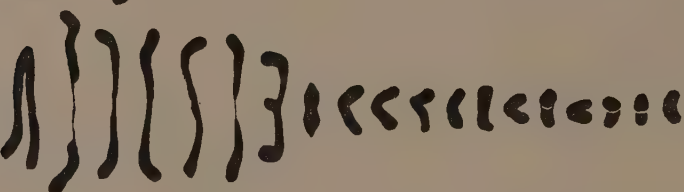
	No. of bivalents							Total
	2	3	4	5	6	7	8	
No. of chrom. complexes								
0	1	3	4	5	10	8	4	36
1		1	10	10	23	16	5	65
2			5	8	8	9	1	31
3			1	5	4	4	2	16
4				1		1		2
Total	1	4	20	29	45	38	12	150

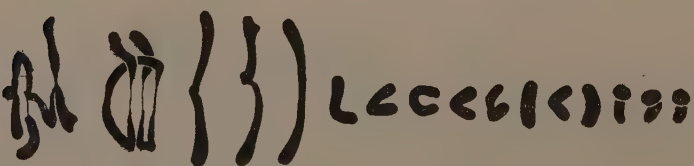
2 

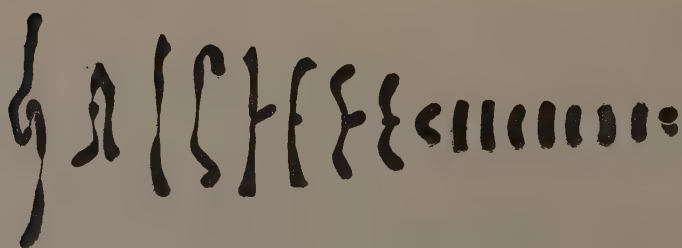
3 

4 

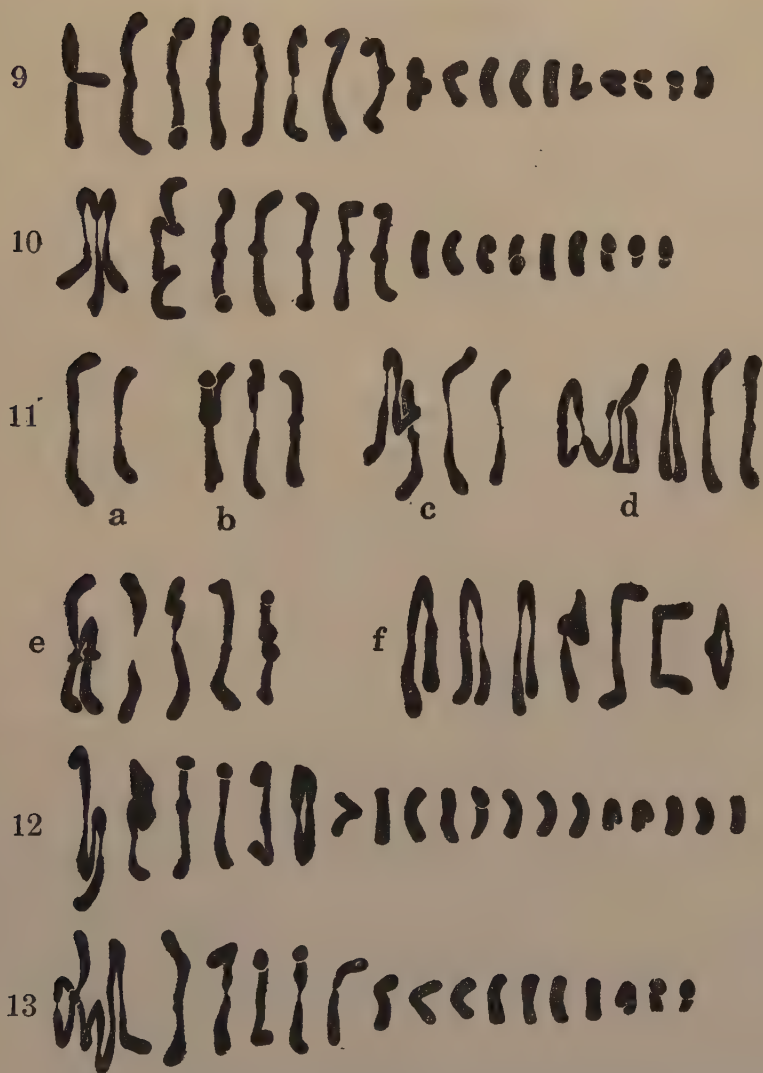
5 

6 

7 

8 





Figs. 2-11. Chromosome conjugation at metaphase of the first maturation division in PMC of *A. sativa* (♀) × *strigosa* (♂).

Fig. 2.  $1V+1III+2II+16I=28$ . Fig. 3.  $1V+1IV+2II+15I=28$ . Fig. 4.  $7II+14I=28$ . Fig. 5.  $1V+1III+4II+12I=28$ . Fig. 6.  $1III+7II+11I=28$ . Fig. 7.  $1VI+1V+3II+11I=28$ . Fig. 8.  $1IV+1III+6II+9I=28$ . Fig. 9.  $1III+8II+9I=28$ . Fig. 10.  $1V+1IV+5II+9I=28$ . Fig. 11. Only bivalents and chromosome complexes are drawn in each PMC. a.  $2II$ . b.  $1III+2II$ . c.  $1V+2II$ . d.  $1VI+1III+2II$ . e.  $1IV+4II$ . f.  $4III+3II$ .

Figs. 12-13. The same of *A. fatua* (♀) × *strigosa* (♂).

Fig. 12.  $1IV+1III+4II+13I=28$ . Fig. 13.  $1VIII+5II+10I=28$ . ×2000.

no noticeable difference in the variations of the number of bivalents and other chromosome complexes. The variation of the number of bivalents ranges from 3 to 9 and the mode is 7. In very rare cases we counted only two bivalent chromosomes in one PMC (fig. 11a). The chromosome conjugation occurs usually in the so called "end to end fashion" in all of gemini, but few closed rings are found (fig. 11f *etc.*). The majority of PMC (*ca.* 84%) have 1-4 chromosome complexes with some bivalents. Most of them are trivalent chromosomes, being V-, Y-, 4- and 4-shaped. Besides, N-, 4-, 4- and 4-shaped tetravalent chromosomes sometimes could be seen, and in rare cases very complicated chromosome complexes consisting of 5-7 elements were found. In figs. 2-11 various chromosome combinations are shown. Fig. 7 shows 11<sub>I</sub>, 3<sub>II</sub> and 2 chromosome complexes which are composed of 5 and 6 chromosomes respectively. The elements forming chromosome complexes are sometimes different in size as shown in the second trivalent from the left in fig. 11f. In the strict sense they do not show complete homology, being semi- or partially homologous.

F<sub>1</sub> hybrids between *A. fatua* and *A. strigosa* which were raised during the two years, 1930 and 1931, were also cytologically studied. They gave the same variation of the number of bivalent chromosomes. Accordingly the results are shown together in table 3c. The conjugation of chromosomes appears to be similar to the above mentioned hybrid, *A. sativa* × *strigosa* (figs. 12 and 13). Close observation, however, shows that the chromosome conjugation in *A. fatua* × *strigosa* is a little weaker. Fig. 13 represents 10<sub>I</sub>+5<sub>II</sub>+one octopartite zigzag chromosome which is a complex with the highest number of elements we have so far found.

As the behavior of chromosomes during the meiotic division is seen to be almost the same as that of the pentaploid *Avena* hybrids (NISHIYAMA 1929), we shall briefly mention the outline of the meiosis in the tetraploid hybrids.

In the early metaphase of the first division, the bivalents and chromosome complexes are arranged on the equatorial plane, but, in general, the univalents are still staying at the poles, as shown in *Triticum-Aegilops* hybrids by KIHARA (1931). Then all the univalents go to the equator and arrange themselves beautifully in ring-like fashion around the bivalents in the first metaphase (fig. 14). After the separated halves of the bivalents have reached the poles, all the univalents divide longitudinally (figs. 15-16). These daughter halves of each univalent move apart and proceed to the opposite poles as if dragged

towards the poles by traction of the spindle-fibers. The chromosome groups of lagging monads usually join with the daughter nuclei (fig. 19) and dyad cells are formed, normal in appearance (Fig. 21). But lagging chromosomes are found in rare cases out of the nucleus, forming micro-nuclei (fig. 22). A few PMC are also observed to show an abnormal appearance, as given in fig. 20, in which lagging chromosomes are bridged between two daughter nuclei. At the first anaphase we could often count the number of univalents and dyads as shown in figs. 17 and 18; the total number of them always amounted 28, being the sum of the haploid number of the parents. The dyads passing to the opposite poles are found in equal or often in unequal numbers. The unequal distribution of dyads is due mainly to the formation of trivalents and other chromosome complexes and partially due to the wandering of univalents without longitudinal splitting. In general, chromosome complexes appear to separate their elements into the same number,  $(u)-(u)$ , to the poles, but into the unequal one  $(u+1)-(u)$ , if the elements are present in an odd number  $(2u+1)$ .

The principal behavior of the second division is almost the same as that of the pentaploid oat hybrids (NISHIYAMA 1929). However, we observed the behavior of monad chromosomes during the division with especial attention. In the anaphase, after the dyad chromosomes have divided longitudinally and have passed to the poles, monad chromosomes are still lying near the equator. They are usually laid uniformly on the equatorial plate or sometimes arranged in ring-like fashion as in the first division (fig. 23). We could not throughout study the behavior of monads during the second metaphase, because it was very difficult to distinguish monads and dyads morphologically. But observations made so far induce the authors to the following conclusion.

As already pointed out by NISHIYAMA (1929) in pentaploid hybrids, the monads are also usually scattered in the whole spindle at the early metaphase of the second division in the present hybrids. But monads generally show less tendency to wander to the poles than the univalents in the first division.<sup>(1)</sup> Therefore, the number of monads scattered in the cytoplasm is usually found to be less than that of the univalents in the first division. In the next stage the monads return to the equatorial region and are arranged around the dyads. If some monads are lying on the equator at the early metaphase, they may be able to arrange themselves freely on that plane as dyads. In the anaphase

---

(1) KIHARA (1931) discussed in detail.

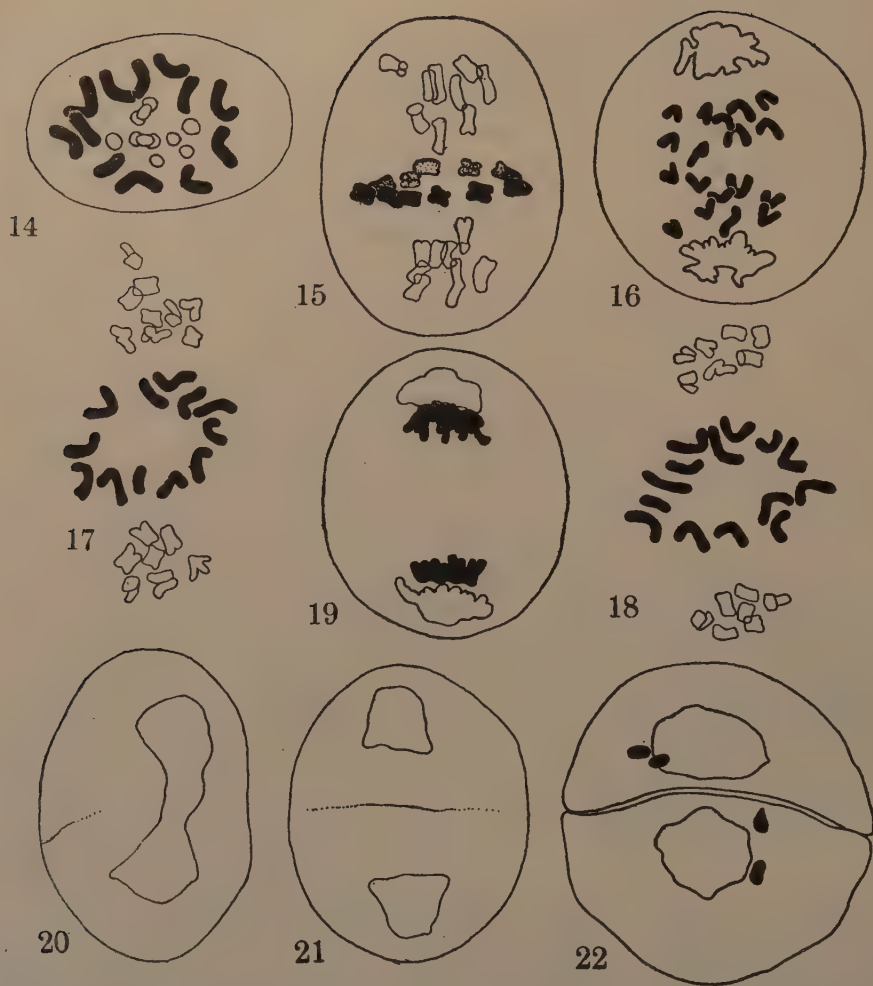


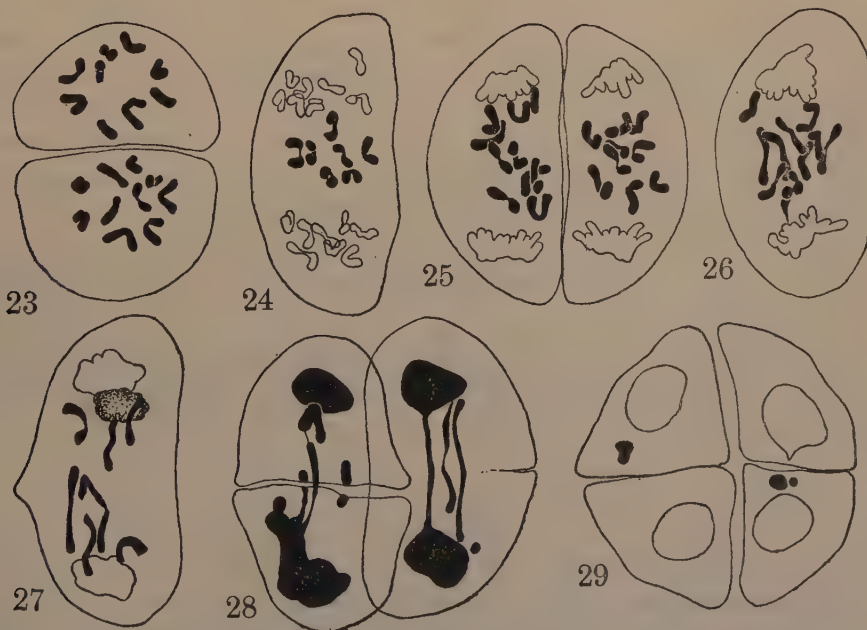
Fig. 14. Metaphase of the first division in PMC of *A. fatua* (♀) × *strigosa* (♂), polar view,  $2_{III}+5_{II}+12_{I}$ .

Figs. 15-22. Anaphase to interkinesis of the first division in PMC of *A. sativa* (♀) × *strigosa* (♂).

Fig. 15. 9 dyads+ $11_{I}+8$  dyads. Fig. 16. 9 univalents have already divided longitudinally and the halves are wandering to the opposite poles. Fig. 17. 9 dyads+ $12_{I}+7$  dyads. Fig. 18. 7 dyads+ $14_{I}+7$  dyads. Fig. 19. Divided halves of univalents have reached the poles. Fig. 20. Chromosome bridge. Fig. 21. Telophase. Fig. 22. Interkinesis with some lost chromosomes. ×2000.



the monads generally lie level to the equatorial plane, and then they begin to wander at random to the poles. At the same time their two arms are gradually stretched to the opposite poles (figs. 24-26). Monads lagging a long time are often seen to be much elongated, as shown in fig. 27. Thus the wandering of monads is distinctly different from that of the split halves of univalents in the first telophase. In literature on the cytology of plant hybrids, the writers have often found figures showing the same behavior of monads during the second telophase, for example *Triticum* (KIHARA 1924 and THOMPSON 1926), *Avena* (NISHIYAMA 1929) etc. At the second telophase we sometimes observed laggard chromosomes bridged between the two poles. Occasionally they were transversely cut into two parts by the cell walls, as shown in Fig. 28. Some lagging monads were often found to make a large chromatin group which came to rest near the daughter nucleus (fig. 27). Usually they later united with each other. The chromosome



Figs. 23-29. The second maturation division in PMC of *A. sativa* (♀) × *strigosa* (♂).

Fig. 23. Anaphase showing only monads which are still lying on the equatorial plane. Figs. 24-27. Anaphase to telophase, lagging monads are distributing to the poles. Figs. 28-29. Tetrads. × 2000.

behavior was more irregular at the telophase of the second division than at the first. Pollen tetrads often represent an abnormal appearance. In addition to a main nucleus each cell sometimes contains several small nuclei (fig. 29).

If 7 chromosomes of *A. strigosa* mate with 7 chromosomes of *A. sativa* or *A. fatua* we may expect  $7_{II}+14_I$  in the metaphase of the first maturation division in PMC of  $F_1$  hybrids, while we have actually counted 2-9 bivalents, in which chromosome complexes are often found. From this fact it may be said that at least two bivalents are formed by the autosynopsis of chromosomes from hexaploid species. On the subject of the conjugation of chromosomes, a more detailed discussion will be attempted in *Avena* in another paper.

## Part II. Embryological studies

Many authors have already made embryological investigations in *Avena*; for example *A. sativa* (GOLINSKI 1893, TANNERT 1905 and ERNST 1908),<sup>(1)</sup> *A. fatua* (CANNON 1900) *A. pubescens* (LÖTSCHER 1905) and *A. flavescens* (SHADOWSKY 1926). TANNERT (1905) fully examined the process of the embryo-sac formation and the development of the embryo. The results of these authors show minute differences owing to the difference of materials. However, the principal process of the formation of the embryo-sac is fairly in agreement. In *Avena* the ordinal type of the embryo-sac development can be found as in the majority of Graminae.

The present observations are limited to embryological development at 3 successive periods, -24, 48 and 72 hours after pollination. Cytological results are given as following :—

### 1. *A. strigosa* SCHREB. and *A. fatua* L.

In these species our observations on the development of self-fertilized ovaries are almost in close agreement with that of previous workers. The writers, therefore, will describe briefly the main mode of their development, to compare them with the abnormal development of ovaries after cross pollination.

---

(1) Cited from SHADOWSKY (1926).

24 hours: In one day after anthesis the fertilization already has been completed. Preparations showing the process of fertilization were not secured. In *A. strigosa* we could sometimes count 14 and 21 chromosomes in the dividing nucleus of the embryo and endosperm respectively. From this fact it may be said that double fertilization was carried out. The same is true in *A. fatua*. The formation of the endosperm proceeds as usual. The successive division of the endosperm nuclei occurs rapidly, and these nuclei are distributed throughout the cytoplasmic layer. As the development proceeds, the endosperm elongates toward the chalaza, but at this time it does not yet begin to encroach upon the nucellar tissue (pl. X, fig. 1). The cytoplasmic lining of the endosperm inverts usually at some points, as shown in fig. 30. Endosperm nuclei are found more numerous in *A. strigosa* than in *A. fatua* (figs. 30 and 43). The fertilized egg cell has successively divided one to three times, so far as the authors examined. Therefore, 2-4-celled embryos are found in one day after anthesis. We could not observe any significant difference in the development of the embryo in the two different species, *A. strigosa* and *A. fatua*. The synergids degenerate gradually and their content is very scanty. Their nucleus lies on the periphery of the cell and only the nucleolus stains deeply with haematoxylin. Many antipodals can always be seen outside of the cytoplasmic lining of the endosperm at the lateral side or sometimes at the chalazal end of the embryo sac. They show vacuolization to a high degree. The antipodals and their nuclei are very large in size and represent a remarkable hypertrophy. In a word, they are degenerating gradually.

48 hours: The endosperm nuclei divide regularly more and more. At the same time the cytoplasm increases its volume. They distribute themselves linearly through the whole cytoplasmic layer around the embryo sac, but in the region of the embryo more numerous nuclei are scattered irregularly (figs. 31 and 44). The densely cytoplasmic layer extends to the periphery of the embryo sac, showing the hollow-sac form, as shown in pl. X, fig. 2. The layer is about equal in thickness, although on the antipodal side it is often somewhat thicker. Only in the neighbourhood of the embryo does the cytoplasm increase with remarkable abundance. The embryo increases in size, and is composed of many cells; it is often hard to count them. Disorganized synergids are often seen, staining darkly with haematoxylin. Antipodals are found at the lateral side of the endosperm as if pressed between the endosperm and the tissue of the nucellus. The nuclei of the antipodal



cells show marked hypertrophy. Cytoplasmic contents are almost empty (pl. X, fig. 2).

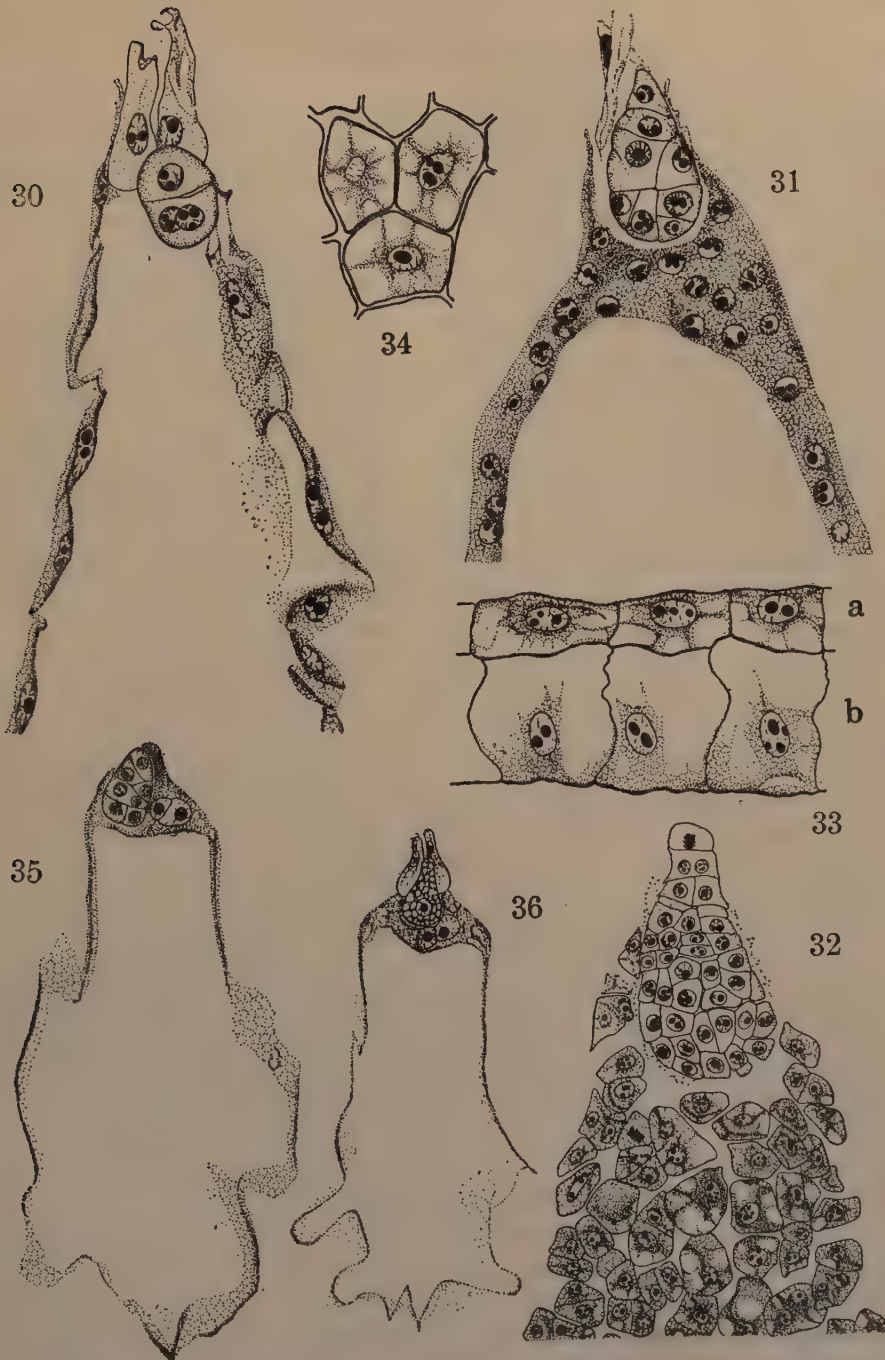
72 hours: Cell walls are first formed in the endosperm near the embryo, and each cell is divided separately. But sometimes two or more adjacent cells are still connected (fig. 32). They contain dense cytoplasm, though they often have large or small vacuoles. The intercellular space is formed especially in this region. In *A. strigosa* usually two or more cell layers of endosperm are formed from the cytoplasmic layer. The first layer of the endosperm tissue consists of small cells compactly placed at the peripheral part. Their contents are somewhat poor. The second layer develops inside the first, proceeding centripetally. The cells of the layer are large, rectangle-shaped in the lateral view (fig. 33). Fig. 34 is drawn from them in the transverse section. At this time the endosperm of *A. fatua* consists generally of many cell layers. The outermost cells are small and are placed compactly. The cells in the second and the inner layers are larger in size. The nucleus lies generally near the cell wall, embedded in scanty cytoplasm. Cytoplasm is present only around the nucleus and from there many strands of cytoplasm run out to the cell wall. We can sometimes see the endosperm tissue inverted into the cavity of the endosperm. Until now no starch grains were found in the endosperm tissue at all. The embryo is growing more and more. The antipodals and synergids are almost entirely dissolved, though sometimes residues of the former are found.

## 2. *A. strigosa* SCHREB. (♀) × *A. fatua* L. (♂)

If the ovary is fertilized it begins immediately to grow. One day after cross pollination, fertilized and unfertilized ovaries are readily distinguished by their size. They were fixed at the same time and kept in separate glass tubes. Results of anatomical observations on the unfertilized ovary are given later with those from *A. fatua* × *A. strigosa*. Hybrid ovaries develop principally in the same manner as in the parents selfed. But some abnormalities which may cause abortive kernels are found in the course of the development.

24 hours: 5-6-celled embryos are formed. The endosperm (both of the cytoplasm and nucleus) increases with remarkable rapidity and extends through the whole cavity of the embryo sac, showing the intermediate appearance between endosperm development of *A. strigosa* 24 and 48 hours after self-pollination. The increase of the endosperm is especially remarkable near the embryo (fig. 37, compare with fig. 30).





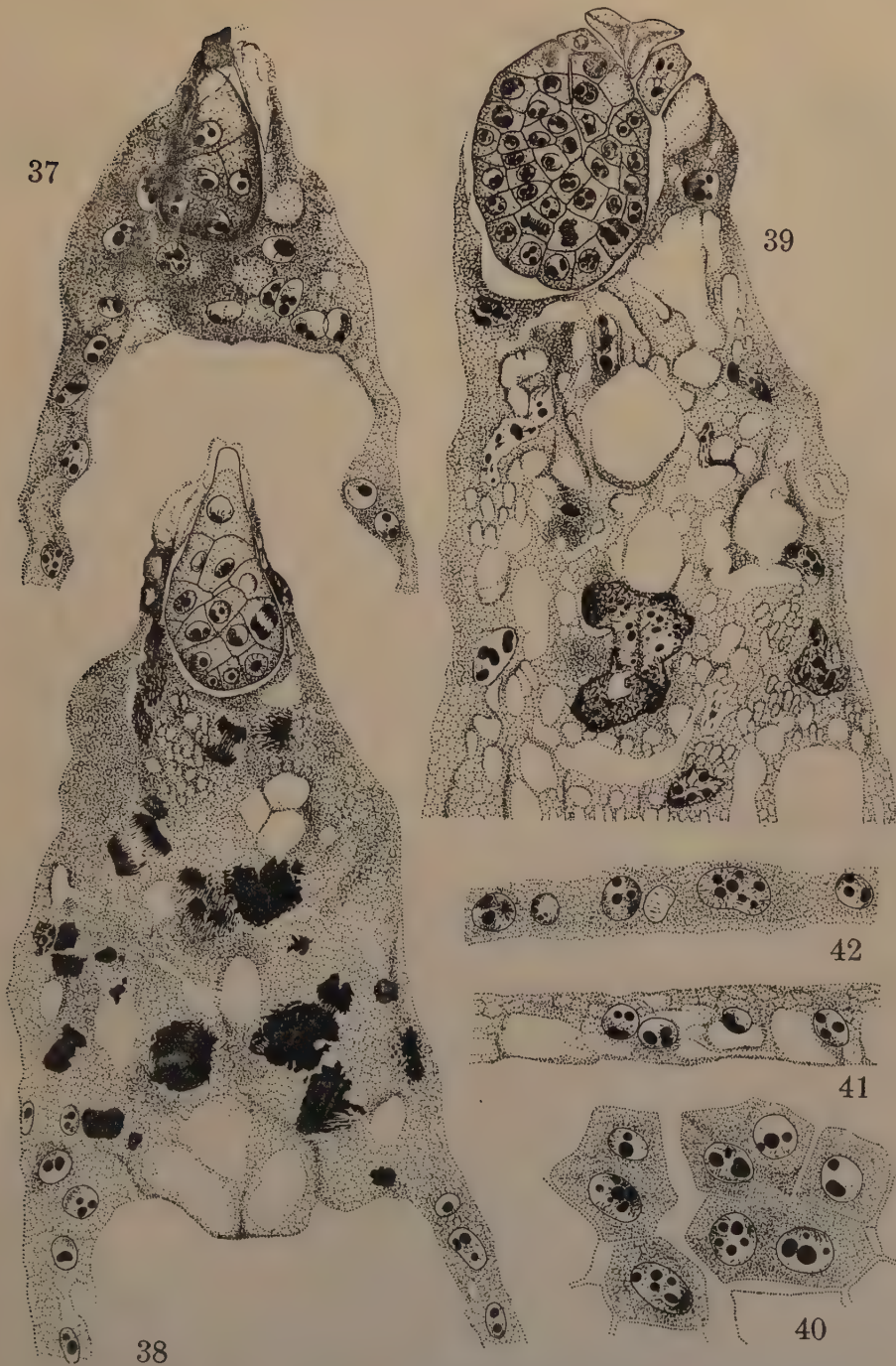
Figs. 30-34. Development of the embryo and endosperm of *A. strigosa* selfed. Fig. 30. Longitudinal section of the ovule 24 hours after anthesis. An embryo, two synergids and endosperm are shown. Fig. 31. The same 48 hours after anthesis. Fig. 32. The same 72 hours after anthesis. Fig. 33. Lateral view of the endosperm tissue in the middle part of the endosperm 72 hours after anthesis. a, the first layer. b, the second layer. Fig. 34. Surface view of the second layer in the same endosperm. Figs. 30-32.  $\times 360$ . Figs. 33 and 34.  $\times 480$ .

Figs. 35 and 36. *A. fatua* ( $\varnothing$ )  $\times$  *strigosa* ( $\sigma$ ). Longitudinal section of ovules 24 hours after pollination. Fig. 35. Fertilized egg cell is developing, and unfertilized polar nuclei lie near the embryo. Fig. 36. Unfertilized ovule.  $\times 175$ .

However, we can not find a pathological abnormality in any respect in the developing ovary.

48 hours: The growth of the hybrid embryo proceeds more rapidly than that of *A. strigosa* selfed. The endosperm also increases remarkably, especially near the embryo. The ovary, therefore, is increasing in size. However, we can observe very abnormal features in the development of the endosperm around the embryo. As shown in fig. 38 and pl. X, fig. 4, numerous large or small vacuoles are seen in the cytoplasm near the embryo. At the same time mitotic divisions of endosperm nuclei are severely disturbed, as illustrated in the same figures. Some nuclei unite with each other and form giant masses of chromatin. They are capable of giving place to further division if the cytoplasmic condition is still favorable. During the division the mitosis is again disturbed, and further larger groups of chromatin are produced. There can be found 2 modes with regard to the fusion of the nucleus. (1). In the anaphase or telophase of the mitosis, 2 daughter nuclei fuse to one large nucleus by the regression of the division without the formation of 2 individual nuclei. (2). Divided nuclei can not be distributed separately in the cytoplasm but lie side by side. In general nuclear divisions occur simultaneously in the neighbourhood at periodic intervals. Accordingly, some dividing nuclei are sometimes in close connection, and unite with each other, giving rise to a large chromatin mass. However, close observation often shows that in the immediate neighbourhood of the embryo the cytoplasm is still dense and compact, and nuclear division proceeds normally. This may be due to the fact that degeneration has not yet come to that region. The endosperm layer forming a hollow sac shows a somewhat abnormal appearance in the part near the degenerating endosperms; that is, this part is in a transitional stage from the degenerating to the healthy endosperm. In the remaining part of the endosperm we can not find any noticeable abnormality. The cytoplasm assumes a dense and compact character, and free nuclei multiply in number. The synergids and antipodals are degenerating in the usual way.

72 hours: The majority of the embryos have not yet presented an unhealthy appearance at all. They consist of more numerous cells; some of them are now normally dividing (fig. 39, pl. X, figs. 5 and 6). Although the endosperm in the upper portion further increases its volume, numerous vacuoles of large or small size are produced. The cytoplasm is sparse and unhealthy. The large nuclei show very irregular shapes. Their contents are more or less dissolved. We some-



Figs. 37-42. Development of the embryo and endosperm in *A. strigosa* (♀)  $\times$  *fatua* (♂). Fig. 37. 24 hours after pollination. Fig. 38. 48 hours after pollination. Fig. 39. 72 hours after pollination. Fig. 40. Abnormal formation of the cellular tissue of the endosperm near the embryo 72 hours after pollination. Fig. 41. Vacuolated endosperm in the same ovary. Fig. 42. Endosperm with dense cytoplasm in the same ovary. Figs. 37-39.  $\times 360$ . Figs. 40-42.  $\times 480$ .



times find nuclei containing nothing but a few chromatic bodies. The degeneration proceeds towards the lower part of the endosperm, and many vacuoles are observed (fig. 41). The formation of the cell wall is not yet clearly perceived. In the chalazal end we sometimes find a dense cytoplasm, in which the free nuclear division occurs normally like that of 48 hours. Numerous free nuclei are linearly embedded in the cytoplasmic layer. Most of them are normal in appearance; but in rare cases giant nuclei are found (fig. 42). We found an ovary which had less endosperm near the embryo in comparison with the usual one. However, the dense endosperm develops very well throughout the embryo sac. The appearance of the cytoplasm is like that of the parent 48 hours after selfing. When a few extraordinarily large vacuoles occupy most of the space in the neighbourhood of the embryo, there is found comparatively less, but dense, cytoplasm, in which free divisions of giant nuclei are often taking place. In rare cases the primitive cell wall is partially developed in this region. As the cell wall formation proceeds to the lower region of the endosperm, it develops more weakly until at last no wall is formed. In this case it is especially noticed that a single cell includes often two or three nuclei, as illustrated in fig. 40. Fig. 41, which is drawn from the middle part of the endosperm, shows the occurrence of numerous vacuoles. In the surface view of these regions we can sometimes find the primitive cell wall, though it is very difficult to identify.

### 3. *A. fatua* L. (♀) × *A. strigosa* SCHREB. (♂)

In the cross *A. fatua* (♀) × *strigosa* (♂) it is very difficult to distinguish the fertilized ovary from the unfertilized one by their size 24 hours after pollination. Therefore, the mixed material was fixed. 17 ovaries were examined microscopically. Out of them 6 (35.3%) showed clearly the development of the embryo and endosperm.

24 hours: The fertilized egg cell grows slowly; in general, 2-4 celled so far as the authors observed. A small number of free nuclei are embedded in the thin cytoplasmic layer which increases less than in selfed ovaries of *A. fatua* (pl. XI, fig. 8 and fig. 45).

48 hours: The embryo grows somewhat, but in the fixed material it appears to be more or less shrunken. The endosperm extends to the tissue of the nucellus. However, it develops weakly, especially near the embryo. The cell wall has already been formed in the endosperm, although its development is very weak (pl. XI, fig. 9 and fig. 46). The



wall usually cuts out only one nucleus in each cell. Fig. 47 is drawn from the peripheral part of the endosperm in the pocket-like cavity in which the embryo lies. Such well developed cells were not always found in our materials. In the surface view we can see the rudimentary cell tissue of the endosperm, although with difficulty, but in the lateral view usually no individual cell is recognized, as illustrated in fig. 48. In the immediate neighbourhood of the embryo the endosperm tissue sometimes represents more or less disorganization, although the cell wall is already formed weakly. The phenomenon occurs in a more extraordinary way after 72 hours. The endosperm consists of the one-celled layer, and in general it forms no more layers of endosperm. The cell content is almost none, or a small quantity of cytoplasm is present only around the nucleus. However, the endosperm placed near the antipodals always has much dense cytoplasm in which few or no vacuoles are observed. The cytoplasm is sometimes cut into individual cells. As will be mentioned later, new endosperm tissue can be secondarily regenerated from this region. Fig. 49 represents a part of the antipodals and the endosperm connecting with them, and fig. 50 the endosperm on the opposite side in the same ovary. These two figures show quite a different appearance. From this fact it is clear that the antipodals are of practical use for the nourishment of the endosperm,

One preparation represented a small embryo without endosperm; only a little residue of the disorganized endosperm was found. The embryo also shrank very much and appeared to be unhealthy. We found only one ovary in which the endosperm with numerous free nuclei was normally developing as in *A. fatua* selfed.

72 hours: Not enough material was obtained to study fully the development of the kernel. The shrinkage of the endosperm, by fixing, prevents us from exact observation.

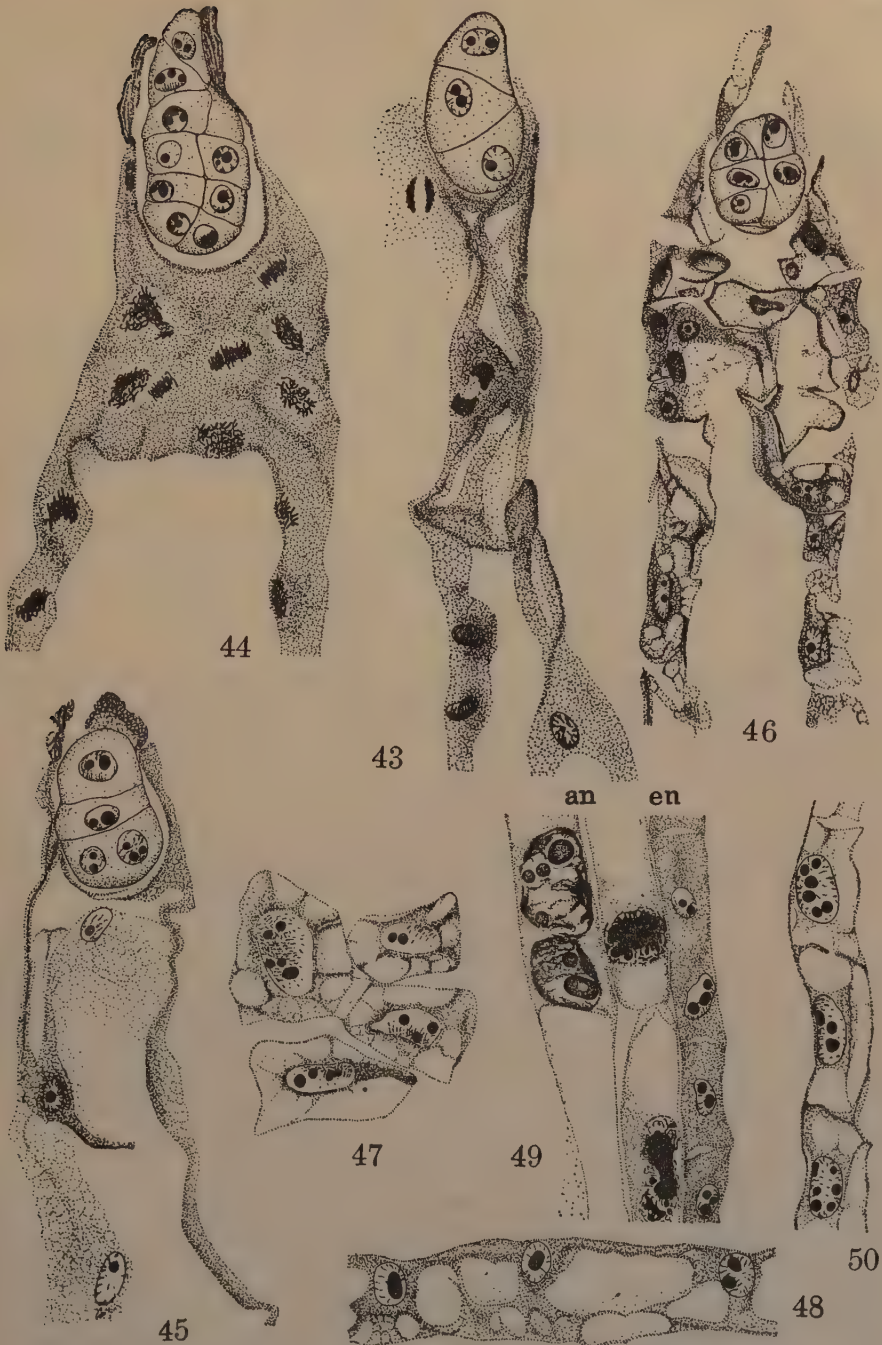
The embryo grows more and more under favorable conditions, but is somewhat smaller than that of the selfed *A. fatua*. Sometimes the embryo consists of a smaller number of cells, and shows degeneration.

The formation of the endosperm is very variable. In general the development of the endosperm is highly arrested. As stated previously, the endosperm near the antipodals is rich with dense cytoplasm, and the endosperm nucleus of this part divides very rapidly without the formation of the cell wall. These free nuclei stay in the region where they divided. They have dense cytoplasm around them (pl. XI, fig. 10). This newly formed endosperm tissue extends usually in all directions and sometimes may occupy the whole cavity of the embryo-sac. The

formation of the cell wall is likely to occur simultaneously. We call the reformed endosperm the regenerate endosperm, and the ordinal one, the original endosperm. The regenerate endosperm is easily distinguished from the original one by its morphological characteristics; that is, the endosperm cell in the former is somewhat smaller in size and is usually filled with fine cytoplasm, especially in the periphery of the endosperm tissue; the old cell has more or less vacuoles; the cell wall develops very weakly; the endosperm cells show weak or no differentiation. The regenerate endosperm forms, in general, a compact tissue of cells as shown in pl. XI. fig. 11. The original endosperm is almost dissolved in the neighbourhood of the embryo, being probably used for nourishment for the embryo. In other regions it is found to give an appearance like that of 48 hours, when a little or no regenerate endosperm is produced. The original endosperm, however, often can not be found in the majority of ovaries in which the regenerate one fills up the entire embryo-sac or occupies most of the cavity. We have in fact observed the disorganization of the original endosperm during the rapid growth of the regenerate one, as shown in pl. XI. fig. 10.

Even if the embryo-sacs are full of endosperm, most of them have no healthy embryo. We have found a few ovaries which have well developed embryos and endosperm, although with minor differences from that of *A. fatua* selfed. By close observation it is proved that the endosperm might be produced through regeneration. These ovaries may grow further and result in good kernels which are able to germinate. In one ovary we found a well developed embryo without endosperm. In such a case the nucellus tissue usually develops very well, but throughout our observations, we have found no evidence to show that the endosperm development is seriously impeded by the growth of the nucellar tissue as stated by MÜNTZING (1930 b) in *Galeopsis* hybrids.

We observed the mode of the development of the young embryo, but no difference was noticed among embryos obtained by crossing and selfing. Fig. 51 shows the mode of cleavage of the embryo. The fertilized egg cell is divided invariably by a transverse wall and results in the 2-celled proembryo. The following divisions have taken place longitudinally in the apical cell and transversely in the basal one. The next time, the middle cell is divided by a longitudinal wall. The division of the lowest cell is transverse or usually more or less oblique. The second and the later divisions have sometimes taken place in irregular sequence. Through 5 successive divisions there is produced the 6-celled embryo.



Figs. 43 and 44. Development of the embryo and endosperm of *A. fatua* selfed. Fig. 43. 24 hours after anthesis. Fig. 44. 48 hours after anthesis.

Figs. 45-50. The same in *A. fatua* (♀) × *strigosa* (♂). Fig. 45. 24 hours after pollination. Fig. 46. 48 hours after pollination. Fig. 47. Weak formation of cellular tissue near the embryo 48 hours after pollination. Fig. 48. Endosperm with many vacuoles in the same ovary. Fig. 49. Antipodals (an) and endosperm (en) with dense cytoplasm, 48 hours after pollination. Fig. 50. The endosperm laid on the opposite side to that in Fig. 49. The cell wall has been weakly formed. Figs. 43-46. × 360. Figs. 47-50. × 480.



The mode of division is almost in agreement with TANNERT's observations in *A. sativa*.

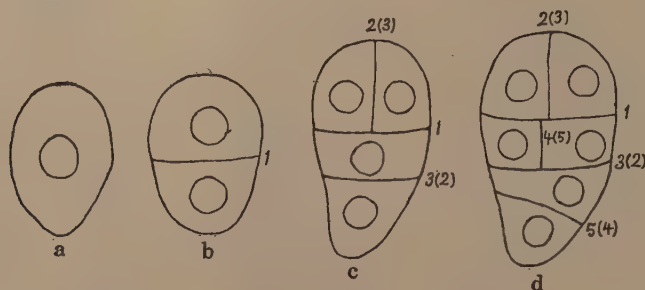


Fig. 51. Cleavage of the embryo. Successive cleavage from the first to the fifth are indicated by numerals.

a. one-celled embryo. b. 2-celled embryo. c. 4-celled embryo. d. 6-celled embryo.

We have obtained an interesting result as to the number of cells forming the embryo 24 hours after pollination, as given in the following (table 4).

TABLE 4

Frequency of the number of cells in the embryo 24 hours after pollination

No. of cells	2	3	4	5	6
<i>A. strigosa</i> selfed	4	4	3		
<i>A. fatua</i> selfed	1	3	1		
<i>A. strigosa</i> (♀) × <i>fatua</i> (♂)				2	2
<i>A. fatua</i> (♀) × <i>strigosa</i> (♂)	3	1	1		

From these results we can see that when *A. strigosa* is crossed with pollens of *A. fatua* the egg cell divides more rapidly than that of the parents selfed. But in the reciprocal cross, on the contrary, the cell division takes place most slowly. In the latter case it is sometimes observed that the embryo development often ceases as early as 2 or 3 days after pollination.

As previously mentioned, we have found some significant abnormalities during the progress of the endosperm development in crossed



kernels. Main processes of the development are briefly summarized as follows (table 5):

TABLE 5

The development of the endosperm

Time after pollination	24 hours	48 hours	72 hours
<i>A. strigosa</i> and <i>A. fatua</i>	Endosperm develops to some extent	Endosperm increases more and more	Cell walls are formed. Endosperm tissue increases remarkably.
<i>A. strigosa</i> (♀) × <i>A. fatua</i> (♂)	Endosperm increases very much, especially in the neighbourhood of the embryo.	Endosperm increases excessively, especially near the embryo. Cytoplasm vacuolates. Some nuclei unite and form large chromatin masses.	Endosperm increases more or less but its degeneration proceeds markedly, <i>i.e.</i> large or small vacuoles occur numerously and many fused nuclei are dissolving.
<i>A. fatua</i> (♀) × <i>A. strigosa</i> (♂)	Endosperm is weakly formed.	Endosperm increases somewhat but its development is almost stopped. Primitive cell walls are already formed.	Sometimes the original endosperm is already dissolved. The regenerate endosperm is often formed.

In the cross *A. strigosa* (♀) × *fatua* (♂), the cytoplasm and free nuclei increase at an abnormal rate of excess during the development of the endosperm in the early stages. However, the excessive increase may disturb the healthy development of the endosperm in an extraordinary way,—*i.e.*, the endosperm development declines very much 48 hours after pollination and at last the endosperm begins to degenerate. All of these ovaries result in empty kernels when ripe. When *A. fatua* is used as the female plant, the fertilized ovary shows the meagre development of the endosperm. Instead of the primary endosperm which sometimes dissolves or stops its growth soon, the new endosperm is regeneratively produced from the original endosperm near the antipodals. The regenerate endosperm often fills the whole cavity of the embryo-sac. The embryo often perishes before the formation of the regenerate endosperm. Some kernels, however, may be able to develop to maturity and give hybrid plants. As already described, we found only one ovary 48 hours after pollination in which

the endosperm was normally developing as in the selfed one of *A. fatua*. Such an ovary also might give rise to a good kernel.

What causes such a remarkable difference in the development of the kernel in the parents and their reciprocal crosses? All of our morphological and anatomical observations showed that the difference was always associated with the relation of the chromosome number of the male nuclei and the egg or polar nuclei. As will be later discussed in detail, however, it is possible that the effect may not be due to the numerical relation itself but to the activating stimulus of the male nuclei which induces the nuclear division in the egg cell and endosperm. If we represent the three genomes of *A. fatua* by A, B and C, each of which contains 7 chromosomes, that of *A. strigosa* provisionally may be shown by A. In selfed *A. fatua* the numerical relation of chromosomes between the male and female nucleus is  $3n(ABC):3n(ABC)$  in the embryo and  $3n(ABC):6n\begin{Bmatrix} ABC \\ ABC \end{Bmatrix}$  in the endosperm, and in *A. strigosa*  $1n(A):1n(A)$  and  $1n(A):2n\begin{Bmatrix} A \\ A \end{Bmatrix}$  respectively. On the other hand, the relation in *A. fatua* ( $\varphi$ )  $\times$  *strigosa* ( $\sigma$ ) will be  $1n(A):3n(ABC)$  and  $1n(A):6n\begin{Bmatrix} ABC \\ ABC \end{Bmatrix}$  in the embryo and endosperm respectively. In both cases the relation decreased to  $\frac{1}{3}$  of the normal one; in other words, the stimulative strength of the male nuclei may be reduced to  $\frac{1}{3}$ . Such a weak stimulus may not be enough to develop the embryo and endosperm normally, in which case faulty development results. On the contrary, *A. strigosa* ( $\varphi$ )  $\times$  *fatua* ( $\sigma$ ) will give  $3n(ABC):1n(A)$  in the embryo and  $3n(ABC):2n\begin{Bmatrix} A \\ A \end{Bmatrix}$  in the endosperm. From both relations it can be seen that the female gamete has been given an excess of  $2n(BC)$  in comparison with the normal relation. Egg and polar nuclei, therefore, may be stimulated by a strength 3 times as great; then they divide in abnormal rapidity and at last they can no longer maintain a healthy development, especially in the endosperm.

#### 4. Unfertilized ovules and abnormal formation of the embryo

The authors did not observe the development of the embryo-sac mother cell. We, however, investigated the fully developed embryo-sac, especially 1-3 days after pollination or anthesis. No significant

difference was found between the apparatuses of the embryo-sac in *A. fatua* and *A. strigosa*,

Embryological studies of *Avena* were already made by GOLINSKI (1893), CANNON (1900)<sup>(1)</sup>, TANNERT (1905) *etc.* Our observations are in agreement with their results. TANNERT (1905) reported that in *A. sativa* the antipodals lay at the chalazal end of the sac. But in other species the antipodals were usually found at the lateral side of the sac. The antipodal complex of *A. strigosa* and *A. fatua* appears to be placed more or less on the lateral side, although it is sometimes found at the chalazal end, owing to the direction of the section (pl. XI, fig. 7). The fully developed embryo-sac was found to belong to the ordinal type.

The unfertilized ovary has a normal appearance 1-2 days after pollination. Fig. 36 is drawn from the unfertilized embryo-sac 48 hours after cross-pollination of *A. fatua* (♀) × *strigosa* (♂). But after 72 hours many vacuoles occur in the cytoplasm and some embryo-sacs begin to disorganize. CANNON (1900) and TANNERT (1905) found in *A. fatua* and *A. sativa* respectively, that the antipodal cells became 30 or more in number before fertilization. We counted 22-35 antipodal cells in some unfertilized ovaries 24 hours after pollination in *A. strigosa* (♀) × *fatua* (♂). Many such antipodal cells are formed through the fact that three primary cells divide two or four times. The same number was also found in the material 72 hours after crossing. It seems, therefore, that the antipodals increase no more in number. Antipodal cells and their nuclei show a great increase in size. We could not count how many nuclei were included in the enlarged cells.

We have observed twice that in one embryo-sac there were formed two embryos, one larger in size than the other, as shown in pl. X, fig. 6. Judging from the situation of the embryo, the larger one might be developed from the ordinal egg cell, and the smaller one from one of the synergid cells. According to SCHNARF (1929) the fertilization of the synergid cell was observed in some species, for example *Iris* (DODEL 1891), *Lilium* (OVERTON, E. 1891), *Taraxacum* (SCHWERE 1896) and *Allium* (HABERLANDT 1923).

We examined many ovaries which were fixed 2 days after crossing, *A. strigosa* (♀) × *fatua* (♂), recorded as unfertilized ones. They were proved microscopically not to be fertilized at all, but one of them had a growing embryo. Near the embryo we found clearly two polar

---

(1) Cited after COULTER and CHAMBERLAIN (1919) and SCHNARF (1929).

nuclei connecting with each other. The cytoplasmic layer of the endosperm had no nucleus at all, but grew a little more (fig. 35). We could count about 28 chromosomes in a dividing cell of the embryo. The egg cell, therefore, was fertilized by one male nucleus, but no triple fusion had taken place between the two polar nuclei and the male nucleus.

## Discussion

### DIFFERENT COMPATIBILITY IN RECIPROCAL CROSSES

As we have already indicated, success in crossing differs remarkably according to reciprocal pollinations in many interspecific or generic crosses. The degree of success varies markedly in different combinations. It is not yet known, in almost all cases, what causes such differences, except for a few instances. However, there are to be found a considerable number of cases in which the difference in reciprocals may be due to the difference in chromosome number of the parents.

WATKINS (1927, 1932) first postulated in *Triticum vulgare*  $\times$  *turgidum* that the poor development of  $F_1$ -kernels was due to the abnormal quantitative relation of genoms between the embryo and endosperm. In the normal case the relation is always 2:3, but in dinkel ( $\varphi$ )  $\times$  emmer ( $\sigma$ ) and in the reciprocal cross they are 5:8 and 5:7 respectively. When the relation is less than the normal one the development is better, than when it is larger. The former relation results in the cross, high chromosome number ( $\varphi$ )  $\times$  low number ( $\sigma$ ), and the latter in the reciprocal cross. This assumption was confirmed by THOMPSON and CAMERON (1928) and THOMPSON (1930 a, b) who repeatedly worked on crossing between emmer and dinkel wheat. However, they assumed that the difference in the seed development was due to the difference in chromosome condition in the endosperm, but they did not enter into the relation of embryo to endosperm. WAKAKUWA (1930) made an extensive number of crosses between wheat species with 7, 14 and 21 chromosomes, and confirmed the observations of previous authors. Besides, he found the remarkable fact that in the cross, low chromosome number ( $\varphi$ )  $\times$  high number ( $\sigma$ ), many wrinkled kernels resulted and their germination was bad, while in the reciprocal cross a small number of kernels were obtained that germinated very well. Applying the hypothesis adopted by THOMPSON and CAMERON (1928), he concluded



that the seed germination was reduced by an increase in the number of haploid or diploid genomes in the endosperm.

MÜNTZING (1930 a, b) histologically showed in *Galeopsis* crosses that the failure of tetraploids ( $\text{♀}$ )  $\times$  diploids ( $\text{♂}$ ) is caused through the faulty development of the endosperm. He pointed out that the chromosome condition in the mother plant tissue which nourishes the embryo-sac was never negligible, and suggested that the relation of the chromosome number of the mother plant to those of the embryo and endosperm plays an important part in the seed development. When the number of chromosomes in the mother plant is larger than that of the embryo, the embryo can not develop. This assumption is, however, hardly applied to many other cases.

THOMPSON (1930 b) and WATKINS (1932) reported that the hypothesis which is offered for wheat may also be applied to many cases in which different degrees of success are found in reciprocal crosses between species with different chromosome numbers. And they concluded that, in general, the successful cross is obtained when the mother plant has a higher chromosome number. WATKINS (1932) further assumed that the failure of crosses sometimes is due to the non-growth of pollen tubes in the style of the mother plant. The chromosome relation between the pollen tube and the style is 1:2 in the normal case. If the relation is 1: more than 2, the pollen tube growth is usually not greatly arrested; whereas if it is 1: less than 2, the growth is greatly reduced. In other words, the pollen tube growth is better in the direction high chromosome number ( $\text{♀}$ )  $\times$  low number ( $\text{♂}$ ) than in the reciprocal cross. However, in the application of his hypothesis, WATKINS (1932) has often met with exceptional cases which are unlikely to be ruled by his hypothesis. This hypothesis, moreover, does not fit even for the reciprocal crosses in wheat and oats. The pollination is successful in these cases always when the male has a higher chromosome number than the female (WAKAKUWA 1930, KIHARA 1932 and present authors pp. 249 and 286). WATKINS' hypothesis and those modified by other authors are, above all, applied with difficulty to the cross between species with the same chromosome number where marked difference is found in the reciprocals. The numerical relation of chromosomes is quite the same in both of these crosses, *e.g.*, *Triticum durum* ( $n = 14$ )  $\times$  *Aegilops ventricosa* ( $n = 14$ ) (KATAYAMA 1931). By this hypothesis it is also very difficult to explain the abnormal process of kernel development in the tetraploid cross in *Avena*. Therefore, we have to take another explanation.

It is generally accepted that fertilization comprises two remarkable events, *i.e.* (1), a union or association of corresponding maternal and paternal nuclei, (2), the activation of the egg and polar nuclei by the male nucleus. To accomplish the first action pollen grains germinate on the stigma; pollen tubes pass through the style, and invade the embryo-sac through the micropyle, and two male nuclei are extruded. At the present time we shall assume, for the sake of convenience, all behaviors of the pollen tubes described above as pollen tube growth.

In certain cross combinations many pollen tubes grow normally in the style of the mother plant, but in the other the tube growth is impossible or very difficult. All transitions between them can be assumed. For convenience in explanation, we may specify 4 classes of pollen tube growth, — normal, weak, difficult and no growth. Though it might be better to examine directly the pollen tube growth in the style, no sufficient data are given at present, so that we have usually had to infer the growth of tubes from whether fertilization succeeds or not. In general it is probable, though not always certain, that the full growth of pollen tube results in fertilization and that even if the development is arrested in a later stage, the fertilized ovary shows a distinct indication of development. If the fertilization occurs as good as in the normal case the pollen tube growth also may be normal. In “weak growth” of pollen tubes about half of the pollinated flowers may be fertilized. When the pollen tube growth is difficult fertilization occurs in rare cases. The class “no growth” contains such cases as those in which no pollen grains germinate at all or some pollens germinate but the tube growth is arrested before they reach the ovary.

As regards the stimulative strength of male nuclei, we may also distinguish 4 grades, — overstrong, normal, weak and no affinity, which results in no union of male and female nuclei. If the embryo and endosperm overgrow abnormally as in *A. strigosa* (♀) × *fatua* (♂), the stimulus of the male nuclei may be assumed to be overstrong. If the growth proceeds normally, the male nuclei may have given a normal stimulus. When the stimulus is weak, the growth of the embryo and endosperm proceed very poorly, and the seeds formed are usually smaller in size. If the affinity is absent between the male nuclei and those of the embryo-sac, although they sometimes are in connection with correspondent nuclei, usually no tendency is found towards the normal nuclear division. As the two moments (pollen tube growth and development of the embryo and endosperm) above given may occur indepen-

dently of each other, various combinations will be obtained, as shown in table 6. We shall mention briefly the main characteristics in seed development in each case. It is unfortunate that we have but few data available for the present study, because in most of the in-

TABLE 6  
Types of different compatibility in crossing

Pollen-tube growth Activating stimulus	Normal (I)	Weak (II)	Difficult (III)	No growth (IV)
Overstrong (1)	$I_{1a}$ *Emmer wheat (♀) × Dinkel wheat (♂)  $I_{1b}$ <i>Avena strigosa</i> (♀) × <i>A. fatua</i> (♂)	$II_{1b}$ * <i>Avena strigosa</i> (♀) × <i>A. abyssinica</i> (♂)	$III_{1a}$ * <i>Datura Stramonium</i> ; $2n$ (♀) × $4n$ (♂)	
Normal (2)	$I_2$ * <i>Avena sativa</i> (♀) × <i>A. fatua</i> (♂)	$II_2$ * <i>Avena barbata</i> (♀) × <i>A. sativa</i> (♂)	$III_2$ * <i>Avena sativa</i> (♀) × <i>A. barbata</i> (♂)	* <i>Galeopsis</i> ; $2n$ (♀) × $4n$ (♂)  * <i>Nicotiana Tabacum sanguinea</i> (♀) × <i>N. rustica</i> (♂)
Weak (3)	$I_{3a}$ <i>Nicotiana rustica</i> (♀) × <i>N. attenuata</i> (♂)  $I_{3b}$ <i>Galeopsis</i> ; $4n$ (♀) × $2n$ (♂)	$II_{3a}$ <i>Nicotiana rustica</i> (♀) × <i>N. Tabacum sanguinea</i> (♂)  $II_{3b}$ <i>Nicotiana Tabacum</i> (♀) × <i>N. Langsdorffii</i> (♂)	$III_{3a}$ <i>Avena fatua</i> (♀) × <i>A. strigosa</i> (♂)	
No affinity (4)	$I_4$	$II_4$ <i>Solanum nigrum</i> (♀) × <i>S. luteum</i> (♂)	$III_4$	

Crosses with \* are not studied embryologically.

vestigations reported only a partial observation was made on this subject. Therefore, we had to classify them into their proper types from incomplete descriptions on characteristics in seed formation. It is hoped, therefore, that sufficient evidence will be given and that they will be placed in the correct types.

In this connection, a description will be given and some examples further will be added for each case.

I<sub>1</sub>

(1) Pollen tube growth is good. All or most of ovaries are fertilized when pollinated.

(2) Fertilized embryo and endosperm usually overgrow or represent a tendency of overgrowth.

(3) In general, seeds may grow as large as the normal size.

(4) Seeds obtained are usually wrinkled or greatly shrivelled when mature.

(5) Seed germination is generally low (I<sub>1a</sub>) or no seed germinates (I<sub>1b</sub>).

In "a" seed development is more or less good and some seeds give rise to seedlings. In "b" seed development is markedly abnormal and all seeds fail to germinate.

To this category belong the following crosses :

I<sub>1a</sub>

♀	♂	
*Emmer (n=14) × dinkel wheat (n=21)		WATKINS (1927, 1932), THOMPSON and CAMERON (1928), THOMPSON (1930 a, b), WAKAKUWA (1930), KIHARA (1932)
*Einkorn (n=7) × emmer wheat (n=14)		WAKAKUWA (1930)

I<sub>1b</sub>

<i>Avena strigosa</i> (n=7) × <i>fatua</i> (n=21)	The authors
* <i>A. strigosa</i> (n=7) × <i>barbata</i> (n=14)	"
*Einkorn (n=7) × dinkel wheat (n=21)	WAKAKUWA (1930)

I<sub>2</sub>

(1) Ditto.

(2-5) Seed development is quite normal.

e.g.

♀	♂	
* <i>Avena sativa</i> (n=21) × <i>A. sterilis</i> (n=21) and the reciprocal cross		NISHIYAMA (1929)
* <i>A. sativa</i> (n=21) × <i>A. fatua</i> (n=21)		The authors
* <i>A. strigosa</i> (n=7) × <i>A. Wiestii</i> (n=7)		"
*Einkorn (n=7) × einkorn wheat (n=7)		WAKAKUWA (1930)
*Emmer (n=14) × emmer wheat (n=14)		"
*Dinkel (n=21) × dinkel wheat (=21)		"



I<sub>3</sub>

- (1) Ditto.
- (2) Development of the embryo and endosperm is very poor.
- (3) Mature seeds are nearly normal or smaller in size than the normal one.
- (4) Seeds are plump or sometimes wrinkled.
- (5) In general hybrid seeds germinate badly.

*e.g.*

I<sub>3a</sub>

♀	♂	
* <i>Datura Stramonium</i> (n=12);		BLAKESLEE, BELLING and FARNHAM
tetraploids × diploids		(1923), BUCHHOLZ and BLAKESLEE
		(1929).
<i>Nicotiana rustica</i> (n=24) × <i>Langsdorffii</i> (n=9)		KOSTOFF (1930)
„	× <i>alata</i> (n=9)	„
„	× <i>attenuata</i> (n=12)	„

I<sub>3b</sub>

*Galeopsis*; tetraploids (n=16) × diploids (n=8) MÜNTZING (1930 a, b)  
*Nicotiana rustica* (n=24) × *glauca* (n=12) KOSTOFF (1930)

I<sub>4</sub>

- (1) Ditto.
- Actual fertilization may not take place.  
 No case is known.

II<sub>1</sub>

- (1) Pollen tube growth is somewhat arrested. About half of ovaries pollinated are fertilized.
- (2) Fertilized embryo and endosperm represent overgrowth.
- (3) Seeds may have the same size as that of mother plant selfed.
- (4) Mature seeds are wrinkled or greatly shrivelled.
- (5) All seeds do not germinate or a few may be viable.

*e.g.*

II<sub>1b</sub>

♀	♂	
* <i>Avena strigosa</i> (n=7) × <i>abyssinica</i> (n=14)		The authors
* <i>A. Wiestii</i> (n=7) ×	„	„

II<sub>2</sub>

- (1) Ditto.
- (2) Development of the embryo and endosperm is normal or nearly normal.
- (3) Size of the mature seeds is normal or little smaller than that of mother plant selfed.
- (4) Most of the seeds are plump of slightly wrinkled.
- (5) Seed germination is very good.

e.g.

♀	♂	
* <i>Avena barbata</i> (n=14) × <i>sativa</i> (n=21)		NISHIYAMA (1929), The authors
* „ „ × <i>sterilis</i> (n=21)		„ „
* <i>Helianthus cucumerifolius</i> (n=17)		
„ × <i>rigidus</i> (n=51)		WAGNER (1932)
„ × <i>macrophyllus</i> (n=51)		„
„ × <i>tuberosus</i> (n=51)		„

II<sub>3</sub>

- (1) Ditto.
- (2) Embryo and endosperm show their weak development.
- (3) Seeds are about normal or smaller in size than the normal ones.
- (4) Seeds are plump or sometimes slightly wrinkled.
- (5) Seeds obtained give more or less seedlings or no seed germinate.

e.g.

II<sub>3a</sub>

♀	♂	
Emmer (n=14) × einkorn wheat (n=7)		WAKAKUWA (1930)
Dinkel (n=21) × „ „		„
„ „ × emmer wheat (n=14)		WATKINS (1927, 1932), THOMPSON and CAMERON (1928), THOMPSON (1930 a, b) WAKAKUWA (1930) and KIHARA (1932).
<i>Nicotiana rustica</i> (n=24)		
„ × <i>Tabacum sanguinea</i> (n=24)		KOSTOFF (1930)

II<sub>3b</sub>

♀	♂	
<i>Nicotiana Rusbyi</i> (n=12) × <i>Langsdorffii</i> (n=9)		KOSTOFF (1930)
<i>N. Tabacum</i> (n=24) × „ „		„
<i>N. rustica</i> (n=24) × <i>longiflora</i> (n=10)		„
<i>N. paniculata</i> (n=12) × <i>Petunia violacea</i> (n=7)		„
<i>N. glauca</i> (n=12) × „ „		„
<i>N. suaveolens</i> (n=16) × „ „		„

II<sub>4</sub>

- (1) Ditto.
- Fertilization usually does not occur.

e.g.

♀	♂	
<i>Solanum nigrum</i> (n=36) × <i>luteum</i> (n=24)		JØRGENSEN (1928)
<i>Nicotiana rustica</i> (n=24)		
„ × <i>Petunia violacea</i> (n=7)		KOSTOFF (1930)
<i>N. Langsdorffii</i> (n=9) × „ „		„

In these cases the parthenocarp or the parthenogenetic development of the embryo and endosperm was often induced.

### III<sub>1</sub>

- (1) Pollen tube growth is difficult. Fertilization takes place in rare cases.
- (2) Fertilized ovaries show overgrowth.
- (3) Seed size is the same as that of mother plant selfed.
- (4) In general, shrivelled seeds result.
- (5) Seeds germinate badly or no seed may germinate.

*e.g.*

#### III<sub>1a</sub>

♀	♂	
* <i>Datura Stramonium</i> (n=12);		BLAKESLEE, BELLING and FARNHAM
diploids × tetraploids.		(1923), BUCHHOLZ and BLAKESLEE
		(1929).

### III<sub>2</sub>

- (1) Ditto.
- (2) Seed development usually proceeds normally.
- (3) Seeds grow to about the normal size.
- (4) Well developed seeds are obtained.
- (5) Germination of seeds is good.

*e.g.*

♀	♂	
* <i>Avena sativa</i> (n=21) × <i>barbata</i> (n=14)		The authors
* <i>A. sterilis</i> (n=21) ×	,,	,,

### III<sub>3</sub>

- (1) Ditto.
- (2) Seed development is much arrested.
- (3) Seeds are smaller or about normal in size.
- (4) Mature seeds are plump or more or less wrinkled.
- (5) Seed germination is usually low or lacking.

*e.g.*

#### III<sub>3a</sub>

♀	♂	
<i>Avena fatua</i> (n=21) × <i>strigosa</i> (n=7)		The authors
* <i>A. sativa</i> (n=21) × <i>strigosa</i> (n=7)		,,
* <i>A. barbata</i> (n=14) × <i>strigosa</i> (n=7)		,,
* <i>A. abyssinica</i> (n=14) × <i>strigosa</i> (n=7)		,,
* <i>A. barbata</i> (n=14) × <i>strigosa</i> (n=7)		,,
<i>Zea mays</i> (n=10)		
× <i>Tripsacum floridanum</i> (n=18)		MANGELSDORF and REEVES (1931)

### III<sub>4</sub>

Fertilization does not occur though a few pollen tubes may grow through the style. This case is theoretically possible, but no actual case is known.

## IV

(1) No pollen germinates on the stigma. Although some pollen tubes may grow in the style, their growth is seriously arrested on their way.

*e.g.*

♀	♂
<i>Galeopsis</i> ; diploids( $n=8$ )	$\times$ tetraploids( $n=16$ ) MÜNTZING (1930 a, b)
<i>Nicotiana rustica</i> ( $n=24$ )	$\times$ <i>Tabacum</i> ( $n=24$ ) KOSTOFF (1930)
,,	$\times$ <i>Datura ferox</i> ( $n=12$ )      ,,

We have made so far a general review of the results of hybridization from two points, *viz.*, pollen tube growth and the development of the embryo and endosperm. As for pollen tube growth, we can not definitely form a general rule. But as for the development of the seeds, we can generally say that the cross high chromosome number ( $\varphi$ )  $\times$  low number ( $\sigma$ ) gives better results than the reciprocal cross. Probably *Helianthus* may be an exception to this rule. In the cross low chromosome number ( $\varphi$ )  $\times$  high number ( $\sigma$ ), when the pollination is successful, the stimulus of the male nuclei for the development of the embryo and endosperm is almost always too strong, and the germination of seeds is very bad. In extreme cases all of them are non-viable.

Working on our assumption, we shall again review some of the results of reciprocal crosses more in detail in the following section.

## AUTOPOLYPLOID

*Datura*: The cross  $2n \times 4n$  with diploids used as female was repeatedly attempted but always failed to set capsules. In very rare cases a few seeds were obtained but all of them did not germinate (BLAKESLEE, BELLING and FARNHAM 1923). In the reciprocal cross these authors successfully obtained many seeds in which numerous small seeds were mixed. These seeds germinated badly and gave a few seedlings with  $3n$ . Besides,  $2n$ - and  $4n$ -seedlings were obtained.

BUCHHOLZ and BLAKESLEE (1929) made extensive observations on the pollen tube growth in crosses between different polyploids in *Datura*. From table 1 in their paper we can abstract some data on pollen tube growth in reciprocal crosses in diploids  $\times$  tetraploids and their parents as follows:



Cross	Germinated pollens on the stigma (%)	Pollen tubes in normal growth (group A) %
♀      ♂		
2n × 2n	95.9	65.7
4n × 4n	75.8	34.2
2n × 4n	85.3	13.3
4n × 2n	94.5	67.4

From this result it is shown that pollens of diploids germinate very well and most of them grow normally within the style of diploids and tetraploids, whereas those of tetraploids always represent slightly low germination and their growth is decidedly bad. BUCHHOLZ and BLAKESLEE (1929) stated that the low germination and great abundance of burst pollen tubes of tetraploids might be due to the frequent occurrence of meiotic abnormalities which amounted to about 30 per cent. Therefore, it may be easily understood that in  $4n \times 4n$ , pollen tubes which grow normally within the style, have been observed as about 30 per cent. less in number than in  $2n \times 2n$  and  $4n$  (♀)  $\times$   $2n$  (♂). While in  $2n$  (♀)  $\times$   $4n$  (♂) the great decrease of the number of normal pollen tubes can not be estimated from the amount of pollen grains produced by abnormal meiotic division. It is generally accepted that mother plant tissues,—*e.g.*, style, ovary *etc.*—secrete chemical substances which induce pollen tube growth. If pollen tubes from diploids may be stimulated fully by substances secreted from diploids, they are also stimulated in the same degree by tetraploids, though the latter may have a larger quantity of such substances by doubling the chromosome number. Then  $1n$  pollen tubes may grow equally in the style of diploids and tetraploids. If the chromatin content of pollens increases by two times  $2n$  pollen tubes may be stimulated less in  $2n$  (♀)  $\times$   $4n$  (♂) than in  $4n \times 4n$ , and resulting in poorer pollen tube growth. This explanation is also available for the investigation in which haploids and diploids are used. But we shall omit further discussion of them, because in these cases meiotic abnormalities often hinder us in our observation. As for the correlation between pollen tube growth and seed development in  $4n$  (♀)  $\times$   $2n$  (♂), BUCHHOLZ and BLAKESLEE (1929) stated as follows :

“ The number of seeds obtained from this cross is very low in proportion to the number of pollen tubes which appear to be available for fertilization. Thus in 1920–21

(BELLING and BLAKESLEE 1922, table 2) 41 capsules were obtained from 62 attempts,  $4n \times 2n$ . These 41 capsules contained 167 seeds, an average of 2.6 seeds per capsule.

"We may safely assume that at least 500 pollen tubes may enter the ovary in the pollinations  $4n \times 2n$ . In estimating the seed to pollen-tube ratio, therefore, we can calculate 1 seed per 192 pollen tubes reaching the ovary. Furthermore, only 16 seedlings were obtained from 167 seeds, which gives a ratio of one seedling per 1900 pollen tubes reaching the ovary. The number of seedlings which are actually triploid plants, and therefore the result of fertilization, is still lower (one  $3n$  plant per 13000 pollen tubes reaching the ovary). This ratio would be widened still further if records of all attempts at pollinations were included, rather than data from seed-bearing capsules only.

"There are always many aborted ovules and small seeds obtained in these crosses,  $4n \times 2n$ , even though the seed capsules contain only a few viable seeds. Some of these ovules have enlarged considerably and may be classified from external appearance as small seeds. There are very many others which enlarged only slightly. Still others too microscopic to be included in seed counts fail to enlarge at all, and correspond in size to the abortive ovules observable scattered over the placental surface in immature capsules of tetraploid plants."

They also mentioned in  $2n (\text{♀}) \times 4n (\text{♂})$  the following :

"Even if an occasional pollen tube should reach the ovules, the chances of obtaining seeds are, as we have shown in the reciprocal cross, only about 1 in 192, and the chances for the survival of seedlings are not over one in 1900."

Judging from this description the seed development appears quite similar to that of tetraploid *Avena* crosses. It may be likely that in  $4n (\text{♀}) \times 2n (\text{♂})$  of *Datura* the fertilization usually occurs but the growth of the ovaries stops mostly in the early stages, and non-viable small seeds result. In the reciprocal cross the hybrid incompatibility may mainly be caused by the difficulty of pollen tube growth as stated by BUCHHOLZ and BLAKESLEE (1929). Occasionally fertilized ovaries failed to germinate (BLAKESLEE, BELLING and FARNHAM 1923), being probably caused by the abnormal development of seeds.

*Primula*: After WATKINS (1932), SANSOME observed in *Primula sinensis* that in  $4n (\text{♀}) \times 2n (\text{♂})$  the pollen tube growth was very favorable but in the reciprocal cross a few germinated pollen tubes grew no longer within the style of diploids. In both cases he failed to get any seeds. This case is like crossing in *Datura*. It seems probable that in  $4n (\text{♀}) \times 2n (\text{♂})$  fertilization may have taken place but fertilized ovaries perish during their early development.

*Campanula*: GAIRDNER (1926) reported that a few germinative seeds were obtained in  $4n (\text{♀}) \times 2n (\text{♂})$  in *C. persicifolia*, but all seeds given by the reciprocal cross did not germinate, though appearing to be

quite normal. GAIRDNER and DARLINGTON (1931) gave further detailed data on crossing experiments. A part of this result will be shown below.

Cross	Number of capsules	Mean number of seeds per capsule	Percentage of germination	Mean number of seedlings per capsule.
♀ ♂ $2n \times 2n$	23	325	55.3	179
$4n \times 4n$	5	130	38.5	58
$2n \times 4n$	22	76	0.6	0.5
$4n \times 2n$	34	18	9.8	1.5

The cross  $2n (\text{♀}) \times 4n (\text{♂})$  produced clearly more seeds than  $4n (\text{♀}) \times 2n (\text{♂})$ , though both of them showed the low production of seeds in comparison with  $2n \times 2n$  and  $4n \times 4n$ , in which the diminution of seed production and its germination may be characteristics of autotetraploids, owing to irregular meiotic divisions. While seed germination is markedly better in  $4n (\text{♀}) \times 2n (\text{♂})$  than in the reciprocal cross. Success is more easily attained in the cross  $4n (\text{♀}) \times 2n (\text{♂})$  than in the reciprocal cross. GAIRDNER and DARLINGTON (1931) found an interesting fact in determining the chromosome number of  $F_1$  seedlings from these crosses. In  $2n (\text{♀}) \times 4n (\text{♂})$  most of germinated seeds were, contrary to expectation, not triploids, but tetraploids; namely, out of 10 seedlings 7 were tetraploids and 2 triploids. In the reciprocal cross,  $4n (\text{♀}) \times 2n (\text{♂})$ , 50 seedlings were examined; the majority of them, 23 individuals, were triploid, 8 tetraploids and 1 diploid (probably parthenogenetic). From these results we can see that in  $2n (\text{♀}) \times 4n (\text{♂})$  triploid seedlings are produced in lesser number than the tetraploid seedlings, which are probably derived by the development of occasional unreduced eggs fertilized by  $2n$  pollen. On the other hand, triploid hybrids are easily obtained in the reciprocal cross. It gives favorable evidence for our assumptions on seed development. Referring to seed production,  $2n$  pollen tubes may grow readily through the style of diploids, but the style of tetraploids arrest the growth of  $1n$  pollen tubes. As mentioned above, pollen tube growth in reciprocal crosses in *Datura* and *Canpanula* was quite different, though the tetraploids in both genera are similarly autopolyploids. The reason for the difference is not definitely known.

*C. persicifolia* (2n) is generally self-sterile, while its autotetraploid has been proved to become moderately self-fertile. It is probable that such physiological changes may induce the pollen tube growth.

#### ALLOPOLYPLOID

*Avena* and *Triticum*: NISHIYAMA (1929) has already made many crosses between *Avena* species with the same or different chromosome number. EMME (1929) also succeeded in the interspecific hybridization between 28- and 42-chromosome plants with great difficulty. In general, interspecific crossing in *Avena* is somewhat difficult, so that crossing results may not always be in agreement owing to different conditions or by different technique. However, we can in general summarize these results and those in the present study as follows:—

Cross	Kernel production	Kernel character	Germination
♀ ♂			
2n × 2n	Easy	Normal development	Very good
4n × 4n	Moderately easy	„	„
6n × 6n	Easy	„	„
2n × 4n	Moderately easy	Large size, very shrivelled	No germination
Recip.	A little difficult	Small size, plump	Good
2n × 6n	Easy	Large size, very shrivelled	No germination
Recip.	Difficult	Small size <sup>1)</sup> , plump or more or less wrinkled	Moderately good
4n × 6n	A little easy	About normal development	Very good
Recip.	More or less difficult	Normal development	Good

Reciprocal crosses between species having the same chromosome number succeed without difficulty and F<sub>1</sub> kernels germinate very well. Kernels are usually obtained more easily in low chromosome number (♀) × high number (♂) than in the reciprocal cross. However, the kernel development and germination are, on the contrary, decidedly prominent in the latter, though in pentaploid hybrids no remarkable difference occurs in the direction of cross.

(1) In *A. sativa* × *strigosa* only one kernel obtained was as large as that of *A. sativa* selfed.



As already mentioned, WAKAKUWA (1930) investigated all possible crosses in *Triticum*, and obtained the following results.

Cross	Kernel production		Germination		Kernel development <sup>(1)</sup>
	Actual number	%	Actual number	%	
Einkorn (n=7) (♀) × Einkorn (n=7) (♂)	32	80.00	28	87.50	A little small in size, plump or somewhat wrinkled
Recip.	27	93.10	15	88.24	„
Emmer (n=14) (♀) × Emmer (n=14) (♂)	94	97.92	92	97.80	About normal
Recip.	128	95.52	118	95.93	„
Dinkel (n=21) (♀) × Dinkel (n=21) (♂)	36	85.71	36	100.00	„
Recip.	33	86.84	32	96.97	„
Emmer (n=14) (♀) × Einkorn (n=7) (♂)	119	73.46	110	93.22	A little small in size, plump or somewhat wrinkled
Recip.	118	81.38	88	74.58	Large or small in size, usually wrinkled
Dinkel (n=21) (♀) × Einkorn (n=7) (♂)	81	62.31	46	56.79	Very small in size, usually wrinkled
Recip.	56	71.79	0	0.00	Large in size, shrivelled
Dinkel (n=21) (♀) × Emmer (n=14) (♂)	113	71.07	108	98.18	Somewhat small in size, plump
Recip.	222	95.28	136	61.26	Large in size, very wrinkled

These results are identical with those of *Avena*.

If *T. dicoccoides* was used as female, the development of the endosperm was sometimes especially poor, e.g., *T. dicoccoides* (♀) × *polonicum* (♂) and *T. dicoccoides* (♀) × *aegilopoides* (♂). In general, the difference in the kernel development in the reciprocals emmer × einkorn was not found to be so remarkable as that in emmer × dinkel

(1) On the kernel development the authors further added more detailed descriptions to those mentioned by WAKAKUWA (1930).

and dinkel  $\times$  einkorn. WAKAKUWA (1930) stated that low germination was associated with poor development of the endosperm.

In *Avena* and *Triticum* there is clearly found a close relation between chromosome number and activating stimulus of male nuclei, — i.e., the more the chromosome number, the stronger the stimulus. The relation of chromosome numbers in male nuclei to those of female or polar nuclei, is shown in the following table:—

Cross	$\frac{\text{Male nucleus}}{\text{Female nucleus}} = E$	$\frac{\text{Male nucleus}}{\text{Polar nuclei}} = P$
$\begin{matrix} \text{♀} & \text{♂} \\ 2n \times 2n \end{matrix}$	$\frac{1}{1} = 1$	$\frac{1}{2} = 0.5$
$4n \times 4n$	$\frac{2}{2} = 1$	$\frac{1}{2} = 0.5$
$6n \times 6n$	$\frac{3}{3} = 1$	$\frac{1}{2} = 0.5$
$2n \times 4n$	$\frac{2}{1} = 2$	$\frac{2}{2} = 1$
$4n \times 2n$	$\frac{1}{2} = 0.5$	$\frac{1}{4} = 0.25$
$2n \times 6n$	$\frac{3}{1} = 3$	$\frac{3}{2} = 1.5$
$6n \times 2n$	$\frac{1}{3} = 0.33$	$\frac{1}{6} = 0.16$
$4n \times 6n$	$\frac{3}{2} = 1.5$	$\frac{3}{4} = 0.75$
$6n \times 4n$	$\frac{2}{3} = 0.67$	$\frac{2}{6} = 0.33$

In the cross between species with the same chromosome number the value of E (male: female nucleus) and P (male: polar nuclei) are  $\frac{1}{1} = 1$  and  $\frac{1}{2} = 0.5$  respectively. Observation has shown that the larger the deviation from the normal relation, the less the percentage of germinated kernel. If the value increases by 2 and 3 times in *Avena* and *Triticum* respectively (e.g.  $2n(\text{♀}) \times 6n(\text{♂})$  where  $E = 3$ ) viable kernels are never obtained. On the contrary, if the value is reduced to  $\frac{1}{3}$  small kernels, which are able to germinate, are obtained in a low proportion. In other words, the value of E for viable kernels is  $\frac{1}{3} > E < 2$  and  $\frac{1}{3} > E < 3$  in *Avena* and *Triticum* respectively. A

similar relation also obtains for the value of P (male: polar nuclei),  $\frac{1}{6} \times P < 1$  and  $\frac{1}{6} \times P < \frac{3}{2}$  in *Avena* and *Triticum* respectively.

*Helianthus*: According to WAGNER (1932) the seed setting is good in the cross  $2n (\varphi) \times 6n (\sigma)$  as in *Avena* and *Triticum*, and the seed germination is also good (44–86%) in this direction of cross. The reciprocal cross, however, gave few seeds. Their germination test is not given. In reciprocal crosses of *Chrysanthemum marginatum* ( $n = 45$ )  $\times$  *morifolium* ( $n = 27$ ), similar results are obtained by SHIMOTOMAI (1931 a, b). From these facts it is clear that the stimulus of male nuclei with higher chromosome number is not too strong in these cases.

In this connection, it is worth to mention that the values (E and P) for viable seeds are very different in different intrageneric hybrids. In *Anena* hybrids, the cross  $2n (\varphi) \times 4n (\sigma)$  gave no germinative seeds, while in *Triticum* the same was successful. In these genera the cross  $2n (\varphi) \times 6n (\sigma)$  gave no viable seeds, but in *Helianthus* the cross gave good seeds.

*Galeopsis*: Viable seeds never resulted in the triploid hybrid from tetraploids ( $n = 16$ )  $\times$  diploids ( $n = 8$ ). MÜNTZING (1930 a, b) actually observed that the failure of tetraploids ( $\varphi$ )  $\times$  diploids ( $\sigma$ ) was due to the death of hybrid seeds (embryo and endosperm) in early development, while the reciprocal cross showed no indication of fertilization. According to MÜNTZING (1930 b) AT- tetraploids may be assumed to be a synthesized species with genoms PPSR<sup>1</sup> from *G. pubescens* (PP) and *G. speciosa* (SS). Meiotic behavior of chromosomes in  $F_1$  hybrids (PP  $\times$  SS) suggests that P and S still have a weak affinity to conjugate. The failure of crossing can be also explained from our hypothesis. The PPSS style induces readily growth of P or S pollen tubes, but the male nuclei have not enough stimulus to activate the development of the embryo and endosperm. Although the stimulus of PS or PR male nuclei to P or S female gametes might be enough or too strong for the development of the embryo and endosperm, PP or SS styles did not admit the PS or PR pollen tube growth. Thus we can explain that the reciprocals are always unsuccessful.

*Aegilops*: According to POPOVA (1929) *Aeg. triuncialis* ( $n = 14$ ) ( $\varphi$ )  $\times$  *crassa* ( $n = 21$ ) ( $\sigma$ ) and *Aeg. cylindrica* ( $n = 14$ ) ( $\sigma$ )  $\times$  *crassa* ( $n = 21$ ) ( $\sigma$ ) gave always hybrid kernels in a low proportion, i.e. 14.3% and 6.2% respectively. Each reciprocal cross also succeeded in about

(1) R is a recombination genom of P and S.

the same percentage as in the direct cross. In these crosses, especially in  $21-(\varnothing) \times 14$ -chromosome species ( $\sigma$ ) two types of hybrid kernels were sometimes obtained, one normal and the other very poorly developed. The latter always failed to germinate. Judging from these results, it seems probable that the development of hybrid kernels is carried out with difficulty even under the best conditions, and under unfavorable conditions the growth of the embryo and endosperm is checked in the early stages, and poorly developed kernels result.

*Brassica*: KAJANUS (1917) stated that *B. napus* ( $n = 18$ ) ( $\varnothing$ )<sup>(1)</sup>  $\times$  *B. rapa* ( $n = 10$ ) ( $\sigma$ ) resulted in 437 good seeds from 38 crossed flowers, but the reciprocal yielded only 13 small shrivelled seeds, which badly germinated, from 19 flowers. NELSON (1927) confirmed the observation of KAJANUS (1912, 1917) in the cross swede (*B. napus*)  $\times$  turnip (*B. rapa*). He made further similar crosses. If rape (*B. napus*) was used instead of swede, turnip ( $\varnothing$ )  $\times$  rape ( $\sigma$ ) set a small number of good viable seeds and the reciprocal gave a few shrivelled seeds. TERASAWA and SHIMOTOMAI (1928) attempted numerous crosses between species with 9-, 10-, and 18-chromosome species. Some results which have an important connection with the present problem are shown in the following table (P. 291).

There can be seen two kinds of cross, one in which a remarkable difference in the setting of seeds is observed in reciprocals, the other, where no difference or very little, occurs. From karyological studies in *Brassica* hybrids (MORINAGA 1929 a,b, TERASAWA and SHIMOTOMAI 1928 SASAOKA 1930 etc.) it is probable that at least 3 different genomes ABC<sup>(2)</sup> can be distinguished, and A, B and C consist of 10, 9 and 8 chromosomes respectively. In general, 10-chromosome species have A, 18-chromosome ones AC and 19-chromosome ones AB. Some crosses (1-3) made by TERASAWA and SHIMOTOMAI (1928), AACC ( $\varnothing$ )  $\times$  AA ( $\sigma$ ) and AACC ( $\varnothing$ )  $\times$  BB ( $\sigma$ ), readily gave many seeds but most of them were non-viable. The reciprocal cross set a few seeds or none, and no seedling was obtained. On the other hand, other combinations (4-6) produced equally a small number of seeds in the reciprocals. The seeds set rarely gave seedlings. As WATKINS (1932) suggested, it seems probable that the dif-

(1) KARPECHENKO (1922) counted 18 haploid chromosomes in *B. napus*, but NAGAI and SASAOKA (1930) found 19 chromosomes in PMC of *B. Napus*.

(2) The names of these genomes are given arbitrarily by the present authors. The identification of this B and B of *B. oleracea* (KARPECHENKO) is not yet made.



Cross	No. of flowers crossed	No. of seeds obtained	No. of ger- minative seeds
♀                      ♂			
(1) <i>B. chinensis</i> (n=10) × <i>B. cernua</i> (n=18)	30	3	0
Reciprocal	30	30	2
(2) <i>B. pekinensis</i> (n=10) × <i>B. cernua</i> (n=18)	30	2	0
Reciprocal	20	67	3
(3) <i>B. oleracea</i> (n=9) × <i>B. juncea</i> (n=18)	30	0	—
Reciprocal	30	54	2
(4) <i>B. campestris</i> (n=10) × <i>B. cernua</i> (n=18)	30	12	2
Reciprocal	30	11	2
(5) <i>B. campestris</i> (n=10) × <i>B. juncea</i> (n=18)	30	18	2
Reciprocal	30	20	1
(6) <i>B. pekinensis</i> (n=10) × <i>B. oleracea</i> (n=9)	50	3	2
Reciprocal	50	1	1
(7) <i>B. chinensis</i> (n=10) × <i>B. oleracea</i> (n=9)	30	3	1
Reciprocal	30	0	—

ference in number of seeds set might be due to whether the style of the seed plant is favorable for pollen tube growth or not. Accordingly, the facts given above may furnish further evidence that pollen tube growth is not always connected with the number of chromosome in parents. In *Brassica*, besides the chromosome number, the difference of Mendelian factors which control the self or cross incompatibility, may play an important part towards success in crossing. Without embryological observations we can not definitely state whether ungerminated seeds are caused by the overgrowth or by less development of the embryo or endosperm, although both of them seem to be probable.

*Raphanobrassica*: WATKINS (1932) has regarded *Raphanobrassica* as an autotetraploid of sterile diploids derived by *Raphanus sativus* (♀) × *Brassica oleracea* (♂). Viewing the genom constitution *Raphanobrassica* (BBRR) is a typical allotetraploid synthesized from *Raphanus* (RR) and *Brassica* (BB).

KARPECHENKO (1928) and KARPECHENKO and SHCHAVINSKAIA (1930) attempted crosses between *Raphanobrassica* and its parental species. The results will be given as follows (table in P. 292):

In this *Raphanus-Brassica* cross we have to remember 3 important facts; (1) Cross succeeds always in one direction *R. sativus* (♀) × *B. ole-*

Cross	No. of seeds set No. of pollinated flowers		Seeds per 100 flowers pollinated (1928 and 1930)	No. of germinated seeds (1930)
	(1928)	(1930)		
RR <sup>♀</sup> × BBRR <sup>♂</sup>	—	$\frac{11}{143}$	7.7	8
BBRR × RR	$\frac{1}{62}$	$\frac{11}{382}$	2.7	9
BB × BBRR	$\frac{0}{74}$	$\frac{0}{411}$	0	0
BBRR × BB	$\frac{2}{206}$	$\frac{2}{551}$	0.5	1
BBRR × BBRR	$\frac{247}{580}$	$\frac{166}{118}$	59.2	150

*racea* (♂) and in the reciprocal cross *sativus* pollens do not germinate or some short pollen tubes grow no longer in the style of *B. oleracea* (KARPECHENKO 1924). (2) In general, F<sub>1</sub> hybrids (BR) are easily fertilized by *R. sativus*, but by *B. oleracea* with great difficulty (KARPECHENKO 1927, 1928). (3) *Raphanobrassica* has become self-fertile though either of the parents are self-sterile (KARPECHENKO 1928). From these results it seems probable that the physiological condition of the style of *Raphanobrassica* becomes different to that of either of the parents, being probably intermediate between them, although crossing experiments seems to show that the physiological function of BB genoms is somewhat prevalent to that of RR. The style BBRR was able to induce the growth of B- or R- pollen tubes with difficulty in *Raphanobrassica* (♀) × *Raphanus* (♂) or *Brassica* (♂). In RR (♀) × BBRR (♂) the growth of BR- pollen tubes might be admitted in the style RR, because BR tubes were intermediate between B and R tubes, or more likely to the B tube which grew easily in the style RR. Since all R- and in incompatible combinations B pollen tubes never grow in the style BB, BR tubes may also fail to grow in BB (♀) × BBRR (♂). From this consideration it is not difficult to explain why the crossing experiment in this combination did not always succeed. In the germination of seeds no remarkable difference was found in these crosses given above. Intergeneric crosses between *R. sativus* (n = 9), and *B. campestris* (n = 10) (KAKIZAKI 1925),

*B. chinensis* ( $n = 10$ ), *B. pekinensis* ( $n = 10$ ) (TERASAWA and SHIMOTOMAI 1928) *B. juncea* ( $n = 18$ ) and *B. cernua* ( $n = 18$ ) (FUKUSHIMA 1929) were repeatedly attempted, and always succeeded when *Raphanus* was male. As already stated, KARPECHENKO always obtained  $F_1$  seeds only in the direction *R. sativus* (RR) ( $\varnothing$ )  $\times$  *B. oleracea* (BB) ( $\sigma$ ). It seems probable that the difference above given may be caused by different *Brassica* species used. KARPECHENKO used for his experiments *Brassica* species with BB, while the other authors those with AA or AACC.

*Nicotiana*: A considerable amount of data on crossing experiments has been reported by many investigators (EAST 1928, CHRISTOFF 1928, KOSTOFF 1930 etc.). CHRISTOFF (1928) stated that out of 66 different crosses made reciprocally between species with different chromosome numbers, 58 clearly showed a higher degree of cross compatibility in high chromosome number ( $\varnothing$ )  $\times$  low number ( $\sigma$ ), than in the reciprocal cross. On the contrary, in other 8 crosses the degree of compatibility appeared to be greater when the female had a lower chromosome number. Different compatibility was also found in the direction of cross between species having the same chromosome number. The other authors' investigations also reached the same general results as CHRISTOFF (1928) obtained.

It is generally accepted that cross incompatibility is due to the retardation of pollen tube growth in the style of the seed plant. From the evidence given above we can see that in the majority of these crosses pollen tubes grow more easily when the female parent has a higher chromosome number. As many pertinent examples of crossing experiments have been quoted by WATKINS (1932), we shall here omit details of this subject.

KOSTOFF (1930) made an interesting embryological study of hybrid seeds. If *Nicotiana paniculata* ( $n = 12$ ), *glauca* ( $n = 12$ ) and *suaveolens* ( $n = 16$ ) were pollinated with *Petunia violacea* ( $n = 7$ ) the fertilized embryo divides to 4-6 cells, but does not grow further. *N. Rusbyi* ( $n = 12$ ) ( $\varnothing$ )  $\times$  *N. Langsdorffii* ( $n = 9$ ) ( $\sigma$ ), *N. rustica* ( $n = 24$ ) ( $\varnothing$ )  $\times$  *longiflora* ( $n = 10$ ) ( $\sigma$ ) and *N. Tabacum* ( $n = 24$ ) ( $\varnothing$ )  $\times$  *Langsdorffii* ( $n = 9$ ) ( $\sigma$ ) gave usually 20-30-celled embryos though some of them sometimes reached 100-celled stage. When the male species had a still higher chromosome number the embryo development proceeded further, e.g., *N. paniculata* ( $n = 12$ ) ( $\varnothing$ )  $\times$  *suaveolens* ( $n = 16$ ) ( $\sigma$ ), *N. rustica* ( $n = 24$ ) ( $\varnothing$ )  $\times$  *glauca* ( $n = 12$ ) ( $\sigma$ ), *Rusbyi* ( $n = 12$ ) ( $\sigma$ ) and *glutinosa* ( $n = 12$ ) ( $\sigma$ ). He measured the size of the embryos of some pure species

and of *N. rustica* ( $n = 24$ ) crossed with some species differing in the chromosome number. The results will be illustrated below.

Cross		Mean length of embryos ( $\mu$ )	Mean breath of embryos ( $\mu$ )	Area of crossed embryos <hr/> Area of <i>rustica</i> embryos selfed
♀	♂			
<i>N. rustica</i> ( $n=24$ )	$\times$ <i>glauca</i> ( $n=12$ )	60	44	$\frac{1}{104}$
„	$\times$ <i>Rusbyi</i> ( $n=12$ )	88	52	$\frac{1}{60}$
„	$\times$ <i>Palmeri</i> ( $n=12$ )	96	68	$\frac{1}{42}$
„	$\times$ <i>Tabacum sanguinea</i> ( $n=24$ )	180	120	$\frac{1}{13}$
„	$\times$ <i>attenuata</i> ( $n=12$ )	280	160	$\frac{1}{6}$
„	$\times$ <i>Langsdorffii</i> ( $n=9$ )	360	180	$\frac{1}{4}$
„	$\times$ <i>alata</i> ( $n=9$ )	420	220	$\frac{1}{3}$
„	selfed	760	360	$\frac{1}{1}$
<i>N. Langsdorffii</i> selfed ( $n=9$ )		660	480	—
<i>N. Tabacum sanguinea</i> selfed ( $n=24$ )		680	500	—
<i>N. rustica humilis</i> selfed ( $n=24$ )		995	760	—

Hybrid embryos usually began to develop normally, but their growth was retarded gradually when compared with that of embryos selfed in the species. If the embryo occupied a smaller area than ca.  $1/13$  of the parallelogram, which is constructed from the mean values of the length and breath of the selfed embryo of *N. rustica*, the cross always gave non-viable seeds. In the cross *N. rustica* (♀)  $\times$  *Tabacum sanguinea* (♂) the hybrid embryos had the limiting value ( $1/13$ ). As can be expected, some of the seeds from this cross did not germinate, while others did. Some of them died in the seedling stage and a few became mature.



According to CHRISTOFF (1928) the crossed seed germinates well in high chromosome number ( $\varphi$ )  $\times$  low number ( $\sigma$ ), but in the reciprocal cross a few seeds were germinative or all of them abortive.

The results are :

Cross	Germination %	Recip. cross
		Germination %
$\varphi$ $\sigma$		
<i>N. nudicaulis</i> (n=24) $\times$ <i>trigonophylla</i> (n=12)	46	0
<i>N. Bigelovii</i> (n=24) $\times$ <i>glutinosa</i> (n=12)	98	less than 1
<i>N. Tabacum</i> (n=24) $\times$ <i>sylvestris</i> (n=12)	50	less than 1
" $\times$ <i>glutinosa</i> (n=12)	25	0
<i>N. rustica</i> (n=24) $\times$ <i>paniculata</i> (n=12)	35	0

As we have no embryological examination in the *Nicotiana* cross low chromosome number ( $\varphi$ )  $\times$  high number ( $\sigma$ ), it is unknown whether non-germinated seeds were produced by the fertilized ovaries or not. It is very interesting to study what causes the formation of non-viable seeds, and how the process of the development of the hybrid ovary takes place if fertilization occurs.

CHRISTOFF (1928) met with some cases where the success of hybridization was not ruled by the numerical relation of chromosomes as shown just above. In *N. suaveolens* (n = 16) ( $\varphi$ )  $\times$  *Tabacum* (n = 24) ( $\sigma$ ) the seed germination amounted as high as 82%, but the reciprocal cross produced capsules without viable seeds. If *N. Bigelovii* (n = 24) was used instead of *N. Tabacum*, hybrid seeds germinated at 98% and at 84% in the reciprocal cross.

In short, the crossing results in *Nicotiana* can not be ruled simply by the numerical relation of chromosomes between pollen and seed plants. They seem to be explained more convincingly by our assumption.

*Fragaria*: *Fragaria* species having the same chromosome number were found to cross readily with each other. However, if the parents differed in chromosome number, the success of reciprocal crosses was remarkably different (MANGELSDORF and EAST 1927 and YARNELL 1931). These authors usually failed to get any seeds in the cross 21- ( $\varphi$ )  $\times$  7-chromosome species ( $\sigma$ ), but the reciprocal cross always gave abundant seeds which developed normally in appearance

but the germination was markedly low or generally resulted in failure. ICHIJIMA (1930) and YARNELL (1931) obtained some viable seeds in both *F. nilgerrensis* ( $n = 7$ )(♀)  $\times$  *elator* ( $n = 21$ )(♂) and the reciprocal, but all plants derived from these crosses were maternal. Such plants might be originated either from pseudogamy or from accidental selfing (YARNELL 1931). MANGELSDORF and EAST (1927) failed to get seeds in 28-(♀)  $\times$  7-chromosome species (♂) without exception. The reciprocal cross readily set many small, poorly developed seeds which produced only a few seedlings. YARNELL (1931) also attempted the same cross between many species and obtained various results. Reciprocal crosses of *F. virginiana* ( $n = 28$ )  $\times$  *F. sp.* FPI 64856 ( $n = 7$ ) and *F. maxima* ( $n = 7$ ) always failed to set seeds. If *F. nilgerrensis* ( $n = 7$ ) was crossed with pollens of *F. chiloensis* ( $n = 28$ ) many non-viable seeds resulted, and the reciprocal also gave some seeds. Out of 48 seeds in the latter one seedling was obtained. In *F. nilgerrensis* ( $n = 7$ )(♀)  $\times$  *F. virginiana* ( $n = 28$ )(♂) more seeds were obtained than in the reciprocal cross, but no seeding was obtained in these crosses. *F. vesca* ( $n = 7$ )(♀)  $\times$  *chiloensis* ( $n = 28$ )(♂) or *virginiana* ( $n = 28$ )(♂) succeeded in setting many seeds. A few of them were germinative. But in the reciprocal cross no seed was produced. When *F. virginiana* ( $n = 28$ ) was a pollen plant *F. collina* ( $n = 7$ ) failed to set seeds. But if the latter was used as male a few viable seeds were obtained (77.4% germination). The same result was shown in *F. chiloensis* ( $n = 28$ )(♀)  $\times$  *maxima* ( $n = 7$ )(♂) and *F. sp.* FPI 64856 ( $n = 7$ )(♂). MANGELSDORF and EAST (1927) as well as YARNELL (1931) succeeded relatively easily in the cross *F. virginiana* ( $n = 28$ )(♀)  $\times$  *elator* ( $n = 21$ )(♂). The germination of seeds was very good, 80-90%. The latter author also made the reciprocal cross but always failed to get seeds.

Judging from the seed production, pollen tube growth was generally much better in low chromosome number (♀)  $\times$  high number (♂) than in the reverse combination. However, in 7-(♀)  $\times$  28-chromosome species (♂) and 21-(♀)  $\times$  28-chromosome species (♂), there were found some exceptional cases in which tube growth might be seriously affected by the physiological difference between the pollen tube and the style of the mother plant. If fertilization takes place, the cross low chromosome number (♀)  $\times$  high number (♂) usually gives many seeds which germinate very badly or do not germinate at all, but the reciprocal cross produces a few seeds; in some cases most of them can germinate well.

## INTERGENERIC CROSS

*Nicotiana-Petunia*: As previously mentioned *Nicotiana* (♀) was often crossed by *Petunia* (♂) but at best fertilized eggs did not grow further than the 4-6-cell stage (KOSTOFF 1930).

*Zea-Tripsacum*: The cross of *Zea mays* ( $n = 10$ )(♀) with *Tripsacum floridanum* ( $n = 18$ )(♂) was successfully made by MANGELSDORF and REEVES (1931), but in the reciprocal cross no seeds were obtained, though many pollen tubes of *Zea* entered the style of *Tripsacum*. After pollination many ovaries began to grow but most of them perished in the course of development. A few matured, but they were shrunken and much smaller than selfed seeds of *Zea*. Only a few seeds gave survived hybrids. The anatomical studies of hybrid seeds suggested the probable causes of the non-viability of fertilized ovaries, *i.e.*, most of them had poorly developed endosperms and malformed embryos.

*Aegilops-Triticum*. It was repeatedly confirmed by many authors that if *Triticum* was female, the cross succeeded with difficulty or often failed, but in the reverse combination many kernels were easily obtained (LEIGHTY, SANDO and TAYLOR 1926, PERCIVAL 1926, and KATAYAMA 1931). Thus it is probable that pollen tubes of *Triticum* may easily grow through the style of *Aegilops* but those of *Aegilops* hardly grow in the *Triticum* style. But no definite relation is found in the development and germination of hybrid kernels in *Aegilops* × *Triticum*. For example, in *Aeg. ventricosa* ( $n = 14$ )(♀) × *T. durum* ( $n = 14$ )(♂), KATAYAMA (1931) always obtained many wrinkled kernels which germinated badly, while the reciprocal cross gave a few well developed kernels which germinated well. On the contrary, if *Aeg. ovata* ( $n = 14$ ) was crossed with pollen of *T. dicoccoides* ( $n = 14$ ), many well developed kernels resulted and the reciprocal cross set a few shrivelled ones which failed to germinate. It is of great interest to note that whichever cross shows a good development of the kernels, poor development is invariably observed in the reciprocal cross. From evidence mentioned above it seems probable that the success and failure in these crosses are not caused by the difference in chromosome number of parents but rather by the qualitative difference of germplasm which causes the difference in the development of the embryo and endosperm,

*Triticum-Secale*. It is generally believed that the intergeneric hybrids can be obtained only in one direction, *Triticum* (♀) × *Secale* (♂). JESENKO (1913) observed that the failure of the cross was due to



the limited growth of *Triticum* pollen tubes. Choosing some compatible varieties, however, GAINES and STEVENSON (1922) as well as MEISTER and TJUMJAKOFF (1928) got successfully a few seeds out of a great number of *Secale* flowers pollinated with *Triticum*. All of these authors noted that both reciprocal crosses produced a considerable number of more or less grown ovaries which failed to germinate, and stated that the growth of these non-viable kernels might be checked in the early stages after fertilization.

*Aegilops-Secale*. LEIGHTY, SANDO and TAYLOR (1926) readily succeeded in *Aeg. ovata* ( $n = 14$ ), *triuncialis* ( $n = 14$ ) and *ventricosa* ( $n = 14$ ) ( $\text{♀}$ )  $\times$  *Secale cereale* ( $n = 7$ ) ( $\text{♂}$ ). The kernels obtained lacked much endosperm and were seriously shrunken. Out of them very few matured hybrids were given.

*Aegilops-Hordeum*. The above mentioned authors obtained 26 poorly developed kernels from 141 flowers of *Aeg. ovata* ( $n = 14$ ) crossed with cultivated barley ( $n = 7$ ). But all of them did not germinate.

In short, it can be seen from the evidence given above that probably in the combination of these remote genera a limited growth of the embryo and endosperm has been stimulated by male nuclei, but that this activating stimulation is too weak to result in a normal development of seeds. At least, the chromosome number of the parents may be a less important matter in these cases than is generally considered.

In the instances above given we can generally distinguish 3 types of pollen tube growth in the cross in polyploid species.

*Datura* type. As suggested by WATKINS (1932), if the chromosomal relation between the pollen tube and the tissue of the style is less than 1:2, pollen tubes grow more easily than in the reverse, *e.g.*, *Datura*, *Nicotiana*, *Galeopsis*, *Primula*, *Fragaria*, *etc.*

*Triticum* type. Pollen tube growth is better when the relation is held in more than 1:2., *e.g.* *Avena*, *Triticum*, *Campanula*, *Fragaria*, *Nicotiana*, *etc.*

*Brassica* type. No remarkable difference in pollen tube growth is found in crosses between plants with different chromosome numbers, no matter in which direction the cross is performed, *e.g.*, some cases in *Brassica*, *Aegilops cylindrica* ( $n = 14$ )  $\times$  *crassa* ( $n = 21$ ), *Aeg. triuncialis* ( $n = 14$ )  $\times$  *crassa* ( $n = 21$ ).

Besides these three types given above, we have often met with some crosses between species with the same chromosome number in



which the successful cross is limited only in one direction, *e.g.*, *Nicotiana rustica* ( $n = 24$ ) ( $\varphi$ )  $\times$  *Tabacum* ( $n = 24$ ) ( $\sigma$ ). In the cross with different genera the direction of cross is often proved to be very important, *e.g.*, *Raphanus-Brassica* and *Triticum-Aegilops*. In these cases it appears probable that the qualitative difference of germplasm or the physiological condition of the style tissue is more affective than the difference of chromosome number in the pollen and seed plant.

It seems that fertilization does not always follow normal pollen tube growth. But this assumption is made only on the external character of the seed. As the present investigation on *Avena* crosses indicates, strongly shrivelled kernels are not always unfertilized. It can generally be stated that normal pollen tube growth results in fertilization. There is, however, no parallelism between normal tube growth and normal development of the embryo and endosperm. As we have already pointed out, seed development depends upon the strength of stimulus of the male nucleus on the female one.

Embryological studies have shown that the development of seeds is arrested in almost all cases in the cross high chromosome number ( $\varphi$ )  $\times$  lower number ( $\sigma$ ), and also in crosses between two remote species or in generic crosses. From these facts we may assume that the stimulation of male nuclei with lower chromosome number, or of nuclei from remote species is weak. On the other hand, the function of male nuclei may increase with the multiplication of chromosome number (*e.g.*  $2n$  ( $\varphi$ )  $\times$   $6n$  ( $\sigma$ ) of *Avena* and *Triticum*), probably also in autopolyploids (*e.g.* *Datura* and *Primula*). In these cases the stimulus is too strong and an abnormal division of the nucleus takes place which follows the degeneration of the tissue. Considering this, it may be concluded that a moderate stimulation of the male nuclei on the female is most important for the normal development of seeds. The grade of stimulation in many cases is roughly proportional to the number of chromosomes of male nucleus to egg or polar nuclei (*Avena*, *Triticum* and many autopolyploids); but this rule can not be applied for the crossing with the same chromosome number (*Aegilops*  $\times$  *Triticum*, KATAYAMA 1931) and some other polyploids (*Nicotiana*, *Brassica*), as well as many other intergeneric crosses.

The cross is usually successful if we use mother plants with a higher chromosome number, because the mitotic division of the nucleus in the embryo and endosperm is normal, though their development is apparently slow. The probability of getting good seeds is considerably higher in this direction of cross than in the reciprocal case, where the

stimulation acts extremely destructively. We can not neglect here also the regeneration of the endosperm in the cross high chromosome number ( $\varphi$ ) $\times$ low number ( $\sigma$ ) in *Avena*, which causes the healthy development of the embryo.

We have discussed so far this problem. The data are so far favorable for our hypothesis. To supply further evidence it is hoped that embryological studies will be made.

### Summary

(1) Interspecific crosses succeed easily between any two of *Avena* species having the same chromosome number.

(2) 7-( $\varphi$ ) $\times$ 14-chromosome species ( $\sigma$ ) sets many large kernels, but when mature they shrivel and never germinate. The reciprocal cross always gives a number of hybrid kernels which germinate very well.

(3) In 7-( $\varphi$ ) $\times$ 21-chromosome species ( $\sigma$ ) many shrivelled kernels are readily obtained. But all of them are non-viable. A few weakly developed kernels are produced in the reciprocal cross. Most of them give rise to hybrid plants.

(4) The reciprocal crosses between 14- and 21-chromosome species give well developed kernels which germinate very well. If 14-chromosome species is used as female the crossing succeeds more easily.

(5) Tetraploid  $F_1$  hybrids *A. sativa* ( $\varphi$ ) $\times$ *strigosa* ( $\sigma$ ) and *A. fatua* ( $\varphi$ ) $\times$ *strigosa* ( $\sigma$ ) are completely sterile by selfing, but a few kernels have been produced from the latter in open pollination.

(6) In both tetraploid hybrids the meiotic behavior has been found to be quite similar. 2-9 bivalents are usually counted at the metaphase of the first maturation division in PMC. Most of PMC often have 1-4 trivalents and sometimes chromosome complexes consisting of 4-8 elements. During the maturation divisions the behavior of the univalent chromosomes is found to be of the *Triticum*-type. The authors have observed that the wandering of halves of univalents or monads shows quite a different appearance in the anaphase of the first and second division.

(7) Fertilization is completed at latest 24 hours after anthesis or cross pollination. There is found no difference in cell division in the selfed and crossed embryos in the early development. The cleavage of

the embryo is almost in agreement with that observed by TANNERT (1905).

(8) Both *A. strigosa* and *A. fatua* ovaries self-fertilized show the rapid growth of the embryo and endosperm. 72 hours after anthesis the cellular tissue of endosperm is formed, but no starch grains are found.

(9) In *A. strigosa* (♀) × *fatua* (♂) the embryo and endosperm grow with great rapidity. But 48 hours after pollination the endosperm represents an abnormal development, especially near the embryo,—i.e., free endosperm nuclei unite and form large chromatin masses; many large or small vacuoles occur in the cytoplasm. After a time the degeneration of the endosperm proceeds more and more. No cellular endosperm has been observed until 72 hours after pollination. The embryo does not yet show an unhealthy appearance but is rather larger in size compared to that of the parent selfed.

(10) The development of the hybrid embryo and endosperm is remarkably retarded in *A. fatua* (♀) × *strigosa* (♂). Primitive cell walls are formed in the endosperm as early as 48 hours after pollination, but their development already has been stopped. However, we have observed the formation of the regenerate endosperm from the original one near the antipodals in the material 2–3 days after pollination. The cell of the original endosperm usually contains scanty cytoplasm, or almost none, but those near the antipodals are filled with dense cytoplasm. The regenerate endosperm increases with great rapidity and often fills the whole embryo-sac cavity.

(11) The difference of seed production in reciprocals was discussed in detail from two stand points,—(1), pollen tube growth and (2), the activating stimulus of the male nuclei. The authors assume that the different development of hybrid seeds in reciprocal crosses may be caused by the different strengths of the activating stimulus of the male nuclei on egg and polar nuclei. This assumption may well be applied generally to many other cases where varying success is met with in reciprocal crosses.

---

This study was made by a grant from the Tōshōgū Foundation. The authors wish to express their gratitude to the Trustees of the Foundation for this support.

---



## Literature cited

- BLAKESLEE, A. F., BELLING, J. and FARNHAM, M. E. (1923). Inheritance in tetraploid *Daturas*. Bot. Gaz. **76**.
- BUCHHOLZ, J. T. and BLAKESLEE, A. F. (1929). Pollen-tube growth in crosses between balanced chromosomal types of *Datura Stramonium*. Genetics **14**.
- CANNON, W. A. (1900). A morphological study of the flower and embryo of the wild oat (*Avena fatua* L.). Proc. Calif. Acad. Sci., 3. Ser., Bot. **1**.
- CHRISTOFF, M. (1928). Cytological studies in the genus *Nicotiana*. Genetics **13**.
- COULTER, J. M. and CHAMBERLAIN, C. J. (1919). Morphology of angiosperms.
- EAST, E. M. (1928). The genetics of the genus *Nicotiana*. Bibliographia Genetica **4**.
- EMME, E. K. (1929). Über pentaploide Haferbastarde. Bull. Appl. Bot. Gen. and Plant-Breed. **20**.
- FUKUSHIMA, E. (1929). Preliminary report on *Brassico-Raphanus* hybrids. Proc. Imp. Acad. Japan **5**.
- GAINES, E. F. and STEVENSON, F. J. (1922). Rye-wheat and wheat-rye hybrids. Journ. Heredity **13**.
- GAIRDNER, A. E. (1926). *Campanula persicifolia* and its tetraploid form, "Telham Beauty." Journ. Gen. **16**.
- and DARLIGTON, C. D. (1931). Ring-formation in diploid and polyploid *Campanula persicifolia*. Genetica **13**.
- GOLINSKI, S. J. (1893). Ein Beitrag zur Entwicklungsgeschichte des Androeceums und des Gynoeceums der Gräser. Bot. Centralbl. **55**.
- ICHIJIMA, K. (1930). Studies on the genetics of *Fragaria*. Zeitschr. f. indukt. Abst. u. Vererb.-Lehre **55**.
- JESENKO, F. (1913). Über Getreide-Speziesbastarde (Weizen-Roggen). Zeitschr. f. indukt. Abst. u. Vererb.-Lehre **10**.
- JØRGENSEN, C. A. (1928). The experimental formation of heteroploid plants in the genus *Solanum*. Journ. Gen. **19**.
- KAJANUS, B. (1912). Genetische Studien an *Brassica*. Zeitschr. f. indukt. Abst. u. Vererb.-Lehre **6**.
- (1917). Über Bastardierungen zwischen *Brassica napus* L. und *Brassica rapa* L. Zeitschr. Pflanzenz. **5**.
- KAKIZAKI, Y. (1925). A preliminary report of crossing experiments with cruciferous plants, with special reference to sexual compatibility and matroclinous hybrids. Japan. Journ. Gen. **3**.
- KARPECHENKO, G. D. (1922). The number of chromosomes and the genetic correlation of cultivated Cruciferae. Bull. Appl. Bot. and Plant-Breed. **13**.



- KARPECHENKO, G. D. (1924). Hybrids of ♀ *Raphanus sativus* L. × ♂ *Brassica oleracea* L. Journ. Gen. **14**.
- (1927). The production of polyploid gametes in hybrids. Hereditas **9**.
- (1928). Polyploid hybrids of *Raphanus sativus* L. × *Brassica oleracea* L. Zeitschr. f. indukt. Abst.-u. Vererb.-Lehre **48**.
- and SHCHAVINSKAIA, S. A. (1930). On sexual incompatibility of tetraploid hybrids. Proc. U.S.S.R. Congr. Gen., Plant- and Anim.-Breed. **2**.
- KATAYAMA, Y. (1931). Über den Ansatz und Keimungsfähigkeit der Körner in reziproken intra- und intergenerischen Bestäubungsversuchen im Weizen-*Aegilops*-Kreise und die Sterilität der F<sub>1</sub>-Pflanzen. (Japanisch). Agriculture and Horticulture **6**.
- KIHARA, H. (1919). Über Cytologische Studien bei einigen Getreidearten. Mit. II. Chromosomenzahlen und Verwandtschaftsverhältnisse unter *Avena*-Arten. Bot. Mag. Tokyo, **33**.
- (1924). Cytologische und genetische Studien bei wichtigen Getreidearten mit besonderer Rücksicht auf das Verhalten der Chromosomen und die Sterilität in den Bastarden. Memoirs Coll. Science, Kyôto Imp. Univ., B. **1**.
- (1931). Genomanalyse bei *Triticum* und *Aegilops*. II. *Aegilotriticum* und *Aegilops cylindrica*. Cytologia **2**.
- (1932). Weitere Untersuchungen über die pentaploiden *Triticum*-Bastarde. II. Japan. Journ. Bot. **6**.
- KOSTOFF, D. (1930). Ontogeny, genetics, and cytology of *Nicotiana* hybrids. Genetica **12**.
- LEIGHTY, C. E., SANDO, W. J. and TAYLOR, J. W. (1926). Intergeneric hybrids in *Aegilops*, *Triticum*, and *Secale*. Journ. Agric. Res. **33**.
- LÖTSCHER, P. K. (1905). Über den Bau und die Funktion der Antipoden in der Angiospermen-Samenanlage. Flora **94**.
- MANGELSDORF, A. J. and EAST, E. M. (1927). Studies on the genetics of *Fragaria*. Genetics **12**.
- MANGELSDORF, P. C. and REEVES, R. G. (1931). Hybridization of maize, *Tripsacum*, and *Euchlaena*. Journ. Heredity **22**.
- MEISTER, N. and TJUMJAKOFF, N. A. (1928). Rye-wheat hybrids from reciprocal crosses. Journ. Gen. **20**.
- MORINAGA, T. (1929 a) Interspecific hybridization in *Brassica*. I. The cytology of F<sub>1</sub> hybrids of *B. Napella* and various other species with 10 chromosomes. Cytologia **1**.
- (1929 b). Intra specific hybridization in *Brassica*. II. The cytology of F<sub>1</sub> hybrids of *B. cernua* and various other species with 10 chromosomes. Japan. Journ. Bot. **4**.
- MÜNTZING, A. (1930 a). Outlines to a genetic monograph of the genus *Galeopsis*. With special reference to the nature and inheritance of partial sterility. Hereditas **13**.

- MÜNTZING, A. (1930 b). Über Chromosomenvermehrung in *Galeopsis*-Kreuzungen und ihre phylogenetische Bedeutung. *Hereditas* **14**.
- NAGAI, K. and SASAOKA, T. (1930). The number of chromosomes in the cultivated *Brassica*. (Japanese). *Japan. Journ. Gen.* **5**.
- NELSON, A. (1927). Fertility in the genus *Brassica*. *Journ. Gen.* **18**.
- NISHIYAMA, I. (1929). The genetics and cytology of certain cereals. I. Morphological and cytological studies on triploid, pentaploid and hexaploid *Avena* hybrids. *Japan. Journ. Gen.* **5**.
- PERCIVAL, J. (1926). The morphology and cytology of some hybrids of *Aegilops ovata* L. ♀ × wheats ♂. *Journ. Gen.* **17**.
- POPOVA, G. M. (1929). Species hybrids in the genus *Aegilops* L. *Bull. Appl. Bot. and Plant-Breed.* **22**.
- SASAOKA, T. (1930). Karyological observations in different interspecific hybrids of *Brassica*. *Japan. Journ. Gen.* **6**.
- SCHNARF, K. (1929). Embryologie der Angiospermen.
- SHADOWSKY, A. (1926). Der antipodiale Apparat bei Gramineen. *Flora* **120**.
- SHIMOTOMAI, N. (1931 a). Bastardierungsversuche bei *Chrysanthemum*. I. *Journ. Science Hiroshima Univ. Series B, Div. 2*, **1**.
- (1931 b). Über die Konjugation der Chromosomen bei zwei Artbastarden von *Chrysanthemum*. *Bot. Mag. Tokyo* **45**.
- TANNERT, P. (1905). Entwicklung und Bau von Blüte und Frucht von *Avena sativa* L. *Diss. Zürich*.
- TERASAWA, Y. und SHIMOTOMAI, N. (1928). Bastardierungsversuche bei *Brassica* und *Raphanus*. *Science Reports Tôhoku Imp. Univ. Fourth Ser.* **3**.
- THOMPSON, W. P. (1926). Chromosome behavior in triploid wheat hybrids. *Journ. Gen.* **17**.
- (1930 a). Shrivelled endosperm in species crosses in wheat, its cytological causes and genetical effects. *Genetics* **15**.
- (1930 b). Causes of difference in success of reciprocal interspecific crosses. *Amer. Nat.* **64**.
- and CAMERON, D. R. (1928). Chromosome numbers in functioning germ-cells of species hybrids in wheat. *Genetics* **13**.
- WAGNER, S. (1932). Artkreuzungen in der Gattung *Helianthus*. *Zeitschr. f. indukt. Abst.-u. Vererb.-Lehre* **61**.
- WAKAKUWA, Sh. (1930). Bestäubungs- und Keimungsversuche in reziproken *Triticum*-Kreuzungen. (Japanisch). *Japan. Journ. Gen.* **6**.
- WATKINS, A. E. (1927). Genetic and cytological studies in wheat. III. *Journ. Gen.* **18**.
- (1932). Hybrid sterility and incompatibility. *Journ. Gen.* **25**.
- YARNELL, S. H. (1931). Genetic and cytological studies on *Fragaria*. *Genetics* **16**.

## Explanation of plates X-XI

### PLATE X

- Fig. 1. Longitudinal section of an ovule of *A. strigosa* 24 hours after anthesis (= text-fig. 30).  $\times 64$ .
- Fig. 2. The same 48 hours after anthesis (= text-fig. 31).  $\times 64$ .
- Fig. 3. *A. strigosa* ovule fertilized by *A. fatua*, 24 hours after pollination (= text-fig. 37).  $\times 64$ .
- Fig. 4. The same 48 hours after pollination (= text-fig. 38).  $\times 64$ .
- Fig. 5. The same 72 hours after pollination (= text-fig. 39).  $\times 64$ .
- Fig. 6. The successive section of the ovule in Fig. 5. Two embryos are shown.  $\times 64$ .

### PLATE XI

- Fig. 7. Unfertilized ovule in *A. fatua* ( $\varphi$ )  $\times$  *A. strigosa* ( $\sigma$ ), 24 hours after pollination.  $\times 96$ .
- Fig. 8. *A. fatua* ovule fertilized by *A. strigosa*, 24 hours after pollination.  $\times 64$ .
- Fig. 9. The same 48 hours after pollination (= text-fig. 46).  $\times 64$ .
- Fig. 10. Beginning of the development of the regenerate endosperm.  $\times 128$ .
- Fig. 11. The regenerate endosperm is formed in the whole embryo-sac.  $\times 43$ .
-

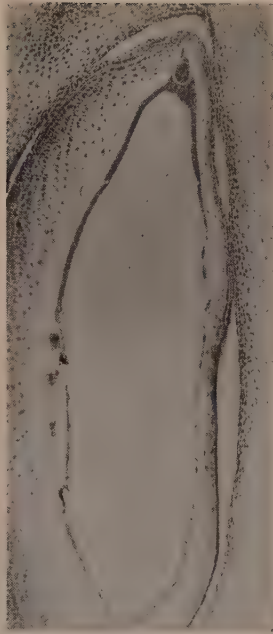




PLATE X



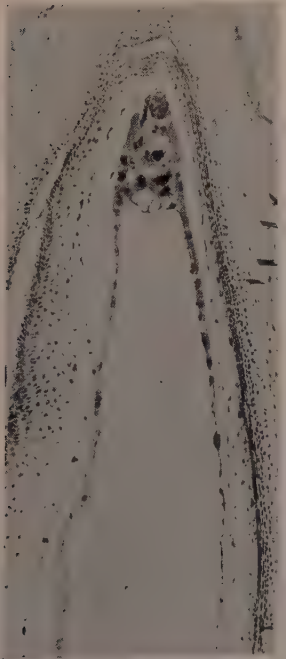
1



2



3



4

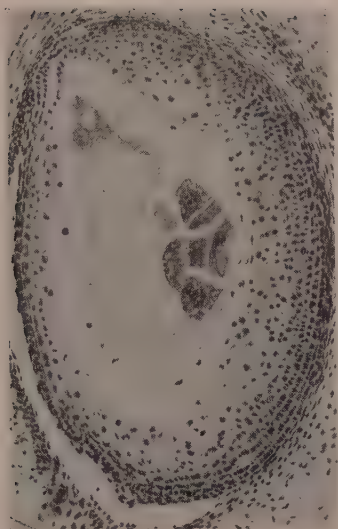


5

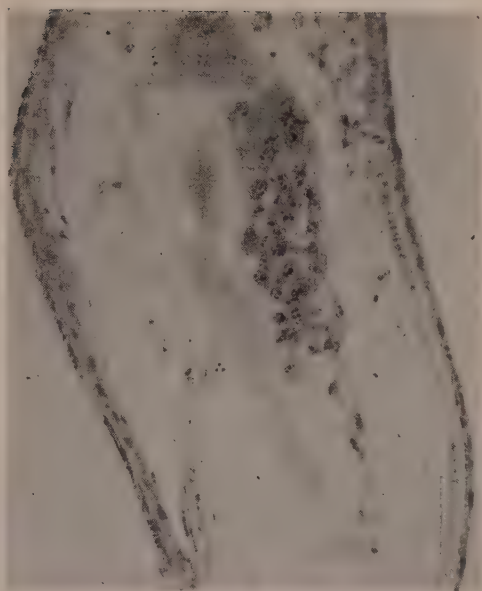


6





7



10



11



9



8





# Phytogeographical position of Japan concerning indigenous genera of vascular cryptogamic plants

By Genkei MASAMUNE

(Received July 19, 1932)

Since the publication of my study on the distribution of the genera of the indigenous flowering plants, I have been making similar studies on the indigenous ferns and fern allies in order to elucidate more completely the phytogeographical position of the Japanese Empire among its neighbouring floral districts as well as their mutual relations. In the present work the result is shown in tabular form. In dividing Japan into the floral districts, I distinguishes their eight as formerly, viz., Kuriles, Sachalin, Yezo, Honsiu, (including Sikoku, and Kiusiu), Riukiu, Formosa, and Bonins. The number of the genera of vascular cryptogams which are at present known to be indigenous to Japan is 89. The names of genera and their distribution in our country and in the neighbouring districts are enumerated in Table I.

TABLE I

Regions Genera indigenous to Japan	Kamtchatka	Kuriles	Sachalin	Yezo	China	Manchuria	Korea	Honsiu, Sikoku & Kiusiu	Riukius	Formosa	Philippines	Bonins
<b>Marattiaceae</b>												
<i>Angiopteris</i> , HOFFM.					+			+	+	+	+	+
<i>Archangiopteris</i> , CHRIST et GIES.					+					+		

(1) G. MASAMUNE: A table showing the distribution of all the genera of flowering plants which are indigenous to the Japanese Empire (Ann. Rep. Taihoku Botanic Garden Vol. 1, 1931).

TABLE I (Continued)

Regions Genera indigenous to Japan	Kamchatka	Kuriles	Sachalin	Yezo	China	Manchuria	Korea	Honsiu, Sikoku & Kiusiu	Riukius	Formosa	Philippines	Bonins
<i>Marattia</i> , SW,											+	+
<b>Ophioglossaceae</b>												
<i>Botrychium</i> , SW.	+	+	+	+	+	+	+	+	+	+	+	
<i>Japanobotrychium</i> , MASA- MUNE										+		
<i>Helminthostachys</i> , KAULF.					+				+	+	+	
<i>Ophioderma</i> , BL.								+	+	+	+	+
<i>Ophioglossum</i> , LINN.	+		+	+	+	+	+	+	+	+	+	+
<b>Hymenophyllaceae</b>												
<i>Hymenophyllum</i> , LINN.				+	+		+	+	+	+	+	
<i>Trichomanes</i> , LINN.		+		+	+		+	+	+	+	+	+
<b>Cyatheaceae</b>												
<i>Alsophila</i> , R. BR.					+			+	+	+	+	+
<i>Cibotium</i> , KAULF.					+				+	+	+	
<i>Cyathea</i> , SMITH.					+			+	+	+	+	+
<b>Polypodiaceae</b>												
<i>Acrophorus</i> , PRESL.								+		+	+	
<i>Acrostichum</i> , LINN.					+				+	+	+	
<i>Adiantum</i> , LINN.			+	+	+	+	+	+	+	+	+	+
<i>Anogramme</i> , LINK.				+	+		+	+				
<i>Antrophyllum</i> , KAULF.					+			+		+	+	
<i>Arthropteris</i> , J. SM.									+	+	+	
<i>Aspidium</i> , SW.					+			+	+	+	+	
<i>Asplenium</i> , LINN.	+		+	+	+	+	+	+	+	+	+	+
<i>Athyrium</i> , ROTH.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Blechnum</i> , LINN.		+		+	+			+	+	+	+	+
<i>Boniniella</i> , HAV.												+
<i>Brainia</i> , J. SM.					+					+	+	
<i>Camptosorus</i> , LINK.				+	+	+	+	+				
<i>Cheilanthes</i> , SW.				+	+	+	+	+	+	+	+	
<i>Cheiropleuria</i> , PRESL.					+			+	+	+	+	

TABLE I (Continued)

Regions Genera indigenous to Japan	Kamtschatka	Kuriles	Sachalin	Yezo	China	Manchuria	Korea	Honsiu, Sikoku & Kjusiu	Riukius	Formosa	Philippines	Bonins
<i>Coniogramme</i> , FEE.		+	+	+	+	+	+	+		+	+	+
<i>Cryptogramme</i> , R. BR.	+	+	+	+	+			+		+		
<i>Cyclophorus</i> , DESV.				+	+	+	+	+	+	+	+	
<i>Cystopteris</i> , BERNH.	+	+	+	+	+	+	+	+	+	+		
<i>Davallia</i> , SMITH.				+	+		+	+	+	+	+	
<i>Denstaedtia</i> , BERNH.					+			+	+	+	+	
<i>Diplazopsis</i> , C. CHR.					+			+		+	+	
<i>Diplazium</i> , SW.				+	+		+	+	+	+	+	+
<i>Dipteris</i> , REINW.					+				+	+	+	
<i>Doryopteris</i> , J. SM.					+					+	+	
<i>Drymoglossum</i> , PRESL.					+		+	+	+	+	+	
<i>Drymotaenium</i> , MAKINO								+		+		
<i>Drynaria</i> , J. SM.					+					+	+	
<i>Dryopteris</i> , ADANS.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Elaphoglossum</i> , SCHOTT.					+			+	+	+	+	
<i>Hemionitis</i> , LINN.					+					+	+	
<i>Histiopteris</i> AG.					+			+	+	+	+	+
<i>Humata</i> , CAV.					+			+	+	+	+	
<i>Hymenolepis</i> , KAULF.					+					+	+	
<i>Hypolepis</i> , BERNH.					+		+	+	+	+	+	
<i>Leptochilus</i> , KAULF.					+			+	+	+	+	+
<i>Lindsaya</i> , DRY.					+		+	+	+	+	+	+
<i>Matteuccia</i> , TODARO		+	+	+	+	+	+	+		+		
<i>Microlepis</i> , PRESL.				+	+	+	+	+	+	+	+	+
<i>Monachosorum</i> , KUNZE.					+			+			+	
<i>Monogramma</i> , SCHK.					+					+	+	
<i>Nephrolepis</i> , SCHOTT.					+			+	+	+	+	+
<i>Notholaena</i> , R. BR.					+					+	+	
<i>Odontosoria</i> , J. SM.					+		+	+	+	+	+	+
<i>Oleandra</i> , CAV.					+					+	+	
<i>Onoclea</i> , LINN.			+	+		+	+	+				
<i>Onychium</i> , KAULF.					+		+	+	+	+	+	+
<i>Pellaea</i> , LINK.					+					+		

TABLE I (Continued)

Regions Genera indigenous to Japan	Kamchatka	Kuriles	Sachalin	Yezo	China	Manchuria	Korea	Honsiu, Sikoku & Kiusiu	Riukius	Formosa	Philippines	Bonins
<i>Peranema</i> , DON.					+					+	+	
<i>Phyllitis</i> , LUDW.		+	+	+	+		+	+			+	
<i>Plagiogyria</i> , METT.				+	+		+	+	+	+	+	
<i>Polybotrya</i> , HUMB. et BOMPL.					+				+	+	+	
<i>Polypodium</i> , LINN.			+	+	+	+	+	+	+	+	+	+
<i>Polystichum</i> , ROTH.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Pteridium</i> , GLED.	+	+	+	+	+	+	+	+	+	+	+	+
<i>Pteris</i> , LINN.					+		+	+	+	+	+	+
<i>Schizoloma</i> , GAUD.					+				+	+	+	
<i>Stenochlaena</i> , J. SM.					+			+		+	+	
<i>Taenitis</i> , WILLD.								+			+	
<i>Tapeinidium</i> , C. CHR.									+	+	+	
<i>Vittaria</i> , SMITH.					+			+	+	+	+	+
<i>Woodsia</i> , R. BR.	+	+	+	+	+	+	+	+		+	+	
<i>Woodwardia</i> , SM.					+			+	+	+	+	
<b>Parkeriaceae</b>												
<i>Ceratopteris</i> , BRONGN.					+			+	+	+	+	
<b>Gleicheniaceae</b>												
<i>Gleichenia</i> , SMITH					+		+	+	+	+	+	
<b>Schizaeaceae</b>												
<i>Lygodium</i> , SW.					+		+	+	+	+	+	
<i>Schizaea</i> , SMITH.									+		+	+
<b>Osmundaceae</b>												
<i>Osmunda</i> , LINN.		+	+	+	+	+	+	+	+	+	+	+
<b>Marsiliaceae</b>												
<i>Marsilia</i> , LINN.					+	+	+	+	+	+	+	
<b>Salviniaceae</b>												
<i>Azolla</i> , LINN.					+		+	+		+	+	
<i>Salvinia</i> , MICHX.					+	+	+	+		+		



TABLE I (Continued)

Regions Genera indigenous to Japan	Kamtchatka	Kuriles	Sachalin	Yezo	China	Manchuria	Korea	Honsiu, Sikoku & Kiusiu	Riukius	Formosa	Philippines	Bonins	
<b>Equisetaceae</b> <i>Equisetum</i> , LINN.	+	+	+	+	+	+	+	+	+	+	+		
<b>Lycopodiaceae</b> <i>Lycopodium</i> , LINN.	+	+	+	+	+	+	+	+	+	+	+	+	
<b>Selaginellaceae</b> <i>Selaginella</i> , SPRING.	+	+	+	+	+	+	+	+	+	+	+	+	
<b>Psilotaceae</b> <i>Psilotum</i> , SW.					+		+	+	+	+	+	+	
<b>Isoetaceae</b> <i>Isoetes</i> , LINN.	+	+	+	+				+					
Total	89	14	18	21	32	77	24	41	66	57	78	75	32
Percentage		16	20	24	36	87	27	46	74	64	88	84	36

From the above table it will be seen that as far as the flora of Japan is concerned, the genera of vascular cryptogams are related to those of the neighbouring districts in the following descending order, viz., China, Philippines, Manchuria, and Kamtchatka.

Table II shows the mutual relationship among various regions. In making this table I firstly took any one of the above mentioned districts, for instance, Kuriles, and tried to find out how many genera indigenous to it (Kuriles) are found in each of the other eleven regions and then calculated their percentages. And in arranging the regions I have put the more related regions in the upper and the less related ones in the lower part of the table.

TABLE II

Number of genera indigenous to Kuriles is 18.			Number of genera indigenous to Sachalin is 21.		
Regions	Number of the genera shared with each region	Percent- ages	Regions	Number of the genera shared with each region	Percent- ages
Yezo	18	100	Yezo	21	100
Honsiu	18	100	Honsiu	21	100
China	17	94	Korea	19	90
Sachalin	16	89	China	19	90
Korea	15	83	Manchuria	18	86
Formosa	15	83	Formosa	17	81
Manchuria	13	72	Kuriles	16	76
Philippines	13	72	Philippines	15	71
Riukius	12	67	Riukius	14	67
Kamtchatka	11	61	Kamtchatka	14	67
Bonins	10	56	Bonins	12	57

Number of genera indigenous to Yezo is 32.			Number of genera indigenous to Korea is 41.		
Regions	Number of the genera shared with each region	Percent- ages	Regions	Number of the genera shared with each region	Percent- ages
Honsiu	32	100	Honsiu	41	100
China	30	94	China	40	98
Korea	29	91	Formosa	36	87
Formosa	26	81	Philippines	34	83
Philippines	24	75	Riukius	32	78
Riukius	23	72	Yezo	29	71
Manchuria	22	69	Manchuria	24	59
Sachalin	21	66	Bonins	20	49
Kuriles	18	56	Sachalin	19	41
Bonins	16	50	Kuriles	15	37
Kamtchatka	14	44	Kamtchatka	12	29

TABLE II (Continued)

Number of genera indigenous to Honsiu is 66.			Number of genera indigenous to Riukius is 57.		
Regions	Number of the genera shared with each region	Percent- ages	Regions	Number of the genera shared with each region	Percent- ages
China	60	91	Formosa	56	98
Formosa	58	88	Philippines	56	98
Philippines	56	85	China	53	93
Riukius	48	73	Honsiu	48	84
Korea	41	62	Korea	32	56
Yezo	32	48	Bonnins	29	51
Bonins	29	44	Yezo	23	40
Manchuria	24	36	Manchuria	18	32
Sachalin	21	32	Sachalin	14	25
Kuriles	18	27	Kuriles	12	21
Kamtchatka	14	21	Kamtchatka	11	19

Number of genera indigenous to Formosa is 78.			Number of genera indigenous is Bonins is 32.		
Regions	Number of the genera shared with each region	Percent- ages	Regions	Number of the genera shared with each region	Percent- ages
China	72	92	Philippines	31	97
Philippines	70	90	Formosa	30	94
Honsiu	58	74	Riukius	29	91
Riukius	56	72	Honsiu	29	91
Korea	36	46	China	28	88
Bonins	29	37	Korea	20	63
Yezo	26	33	Yezo	16	50
Manchuria	21	27	Manchuria	13	41
Sachalin	17	22	Sachalin	12	38
Kuriles	15	19	Kuriles	10	31
Kamtchatka	12	15	Kamtchatka	8	25

Lastly I give Table III showing the "percentage of affinity" which is calculated by taking the average (arithmetic mean) of the percentages of any two floral regions. In the table I have arranged the regions according to the order of the affinity, as I did in Table II.

TABLE III

	Kuriles		Sachalin		Yezo
Sachalin	83%	Yezo	83%	Sachalin	83%
Yezo	78	Kuriles	83	Korea	81
Honsiu	64	Honsiu	66	Kuriles	78
Korea	60	Korea	66	Honsiu	74
Formosa	51	Formosa	52	Formosa	57
Riukius	44	Bonins	48	Riukius	56
Bonins	44	Riukius	46	Bonins	50

	Korea		Honsiu		Riukius
Honsiu	81%	Formosa	81%	Formosa	85%
Yezo	81	Korea	81	Honsiu	79
Riukius	67	Riukius	79	Bonins	71
Formosa	67	Yezo	74	Korea	67
Sachalin	66	Bonins	68	Yezo	56
Kuriles	60	Sachalin	66	Sachalin	46
Bonins	56	Kuriles	64	Kuriles	44

	Formosa		Bonins
Riukius	85%	Riukius	71%
Honsiu	81	Honsiu	68
Korea	67	Formosa	66
Bonins	66	Korea	56
Yezo	57	Yezo	50
Sachalin	52	Sachalin	48
Kuriles	51	Kuriles	44



# Genetical and cytological studies on species hybrids in *Quamoclit*

By Fuyuwo KAGAWA and Goichi NAKAJIMA

---

With plates XII-XV and 14 text-figures

---

(Received August 27, 1932)

## Table of contents

	Page
I. External characters and chromosomes of <i>Quamoclit</i> species . . .	315
II. Crossing experiments and cytology of F <sub>1</sub> hybrids . . . . .	317
A. <i>Quamoclit angulata</i> × <i>Quamoclit pennata</i> . . . . .	317
B. <i>Q. coccinea</i> , var. <i>hederifolia</i> × <i>Q. pennata</i> . . . . .	323
C. <i>Q. Sloteri</i> × <i>Q. pennata</i> . . . . .	324
III. Summary . . . . .	324
IV. Literature cited . . . . .	326
V. Explanation of plates XII-XV . . . . .	327

---

## I. External characters and chromosomes of *Quamoclit* species

*Quamoclit Sloteri* is said to be a hybrid species formed between *Q. coccinea* and *Q. pennata* (*Q. vulgaris*). According to BAILEY (1924), it was originated by Logan SLOTER in Ohio, U.S.A., and introduced by DREER in 1912.

The leaves of *Q. Sloteri* are semi-palmately lobed into long acuminate segments (pl. XII, 1, 2). *Q. coccinea* comprises some varieties which are different from each other in the characters of leaves, flowers and others. According to Dr. MAKINO, the leaves of *Q. coccinea* are ovate-cordate, acuminate and entire. He gave the name *Q. angulata* to the plants having analogous leaves and presenting projections at their base (pl. XII, 5, 6). However, *Q. angulata* may be recognized as one of the varieties of *Q. coccinea*.

*Q. coccinea* var. *hederifolia* used by the writers has the leaves which are divided into 5 lobes (pl. XIII, 9, 10). In *Q. pennata* the leaves are pinnately divided showing feathery appearance (pl. XIII, 13, 14).

Thus, the leaves of *Q. Sloteri* may be said to present the shape intermediate between those of *Q. pennata* and *Q. coccinea* or its varieties.

The shape of corolla is, when seen from above, obtusely pentagonal in *Q. Sloteri*, *Q. angulata* and *Q. coccinea* var. *hederifolia* (pl. XII, 3, 7; pl. XIII, 11), while in *Q. pennata* it is star-shaped with 5 projections (pl. XIII, 15).

The flower colour was decided according to RIDGWAY's Color Standard and Color Nomenclature (1912). In *Q. Sloteri* it is between "scarlet red" and "spectrum red," in *Q. angulata* "scarlet," in *Q. coccinea* var. *hederifolia* "scarlet" approaching to "scarlet red." *Q. pennata* which was used in the present study comprises two strains, of which one has dark "rose red" and the other white flowers.

*Q. Sloteri* is, if compared with other species, considerably vigorous in its vegetative growth with larger flowers, though its fertility is not so high as in other species.

The size of pollen grains is about the same among *Q. angulata*, *Q. coccinea* var. *hederifolia* and *Q. pennata*, while in *Q. Sloteri* it is much larger (pl. XII, 4, 8; pl. XIII, 12, 16).

The somatic number of chromosomes in root tips was reported by one of the writers (NAKAJIMA, 1931) as 58 in *Q. Sloteri*, 28 in each of *Q. angulata* and *Q. coccinea* var. *hederifolia* and 30 in *Q. pennata*. Thus, in *Q. Sloteri* the number of chromosomes is equal to the sum of that of *Q. angulata* or *Q. coccinea* var. *hederifolia* on one hand and *Q. pennata* on the other.

According to KANO (1929), the haploid chromosome number is 30 in *Q. Sloteri* and 15 in *Q. angulata*. The writers' materials are the pedigrees of the species in which the above stated chromosome countings of NAKAJIMA were made, and the numbers in these two species differ from those of KANO. At first the writers also were of the opinion that the somatic number is 60 in *Q. Sloteri* and 30 in *Q. angulata*. But in later countings on a larger number of root tip cells, it became clear that these two species in our materials show the numbers 58 and 28 respectively as above stated. KANO reported

15 as the haploid number of *Q. pennata*, and this corresponds to our number observed in this species. According to our experience the counting of chromosomes in *Quamoclit* can be made more easily in root tip cells than in P.M.C.-s.

Basing on the above stated facts regarding the external characters and chromosomes of *Quamoclit* species, the following conclusion seems to be probable: *Q. Sloteri* ( $2n = 58$ ) might have been a new constant species which was derived from the doubling of chromosomes of the  $F_1$  plant, the result of a natural cross between *Q. pennata* ( $2n = 30$ ) and *Q. coccinea* or its varieties ( $2n = 28$ ). Analogous examples are known in *Primula*, *Aegilotricum* and other forms of plants.

## II. Crossing experiments and cytology of $F_1$ hybrids

The crosses were made according to the following combinations:

- A. *Q. angulata*  $\times$  *Q. pennata* (with dark "rose red" flowers) . . (1)  
*Q. angulata*  $\times$  *Q. pennata* (with white flowers) . . . . . (2)

The parents in (1) seem to be analogous with those which were used by NOHARA (1930) in his crossing experiments between *Q. coccinea* and *Q. pennata*. The writers got 75  $F_1$  plants in (1) and 34 in (2), of which the external characters are in main analogous with those reported by NOHARA regarding his  $F_1$ .

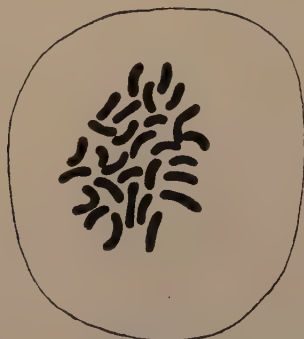
Between (1) and (2) there is no difference in the shape of leaves and flowers. The leaf shape is intermediate between that of the two parents (pl. XIV, 17, 18); compared to the leaf of *Q. Sloteri* it is less broad, its thinner consistency being apparently softer.

The shape of flowers of  $F_1$  is also intermediate between that of the two parents (pl. XIV, 19), and is much more star-shaped than in the flowers of *Q. Sloteri*. They are smaller than those of *Q. Sloteri*. The flower colour of  $F_1$  is quite the same in both cases in spite of the difference of flower colour of the pollen plant in (1) and (2); it resembles that of *Q. Sloteri*, but slightly darker, approaching to "spectrum red."

All  $F_1$  plants were completely sterile.

The somatic number of chromosomes of  $F_1$  was counted in root tips,<sup>(1)</sup> and there were found 29 chromosomes, i.e. the sum of the haploid chromosomes of the parents (text-fig. 1).<sup>(2)</sup>

As above stated, the characters of  $F_1$  resemble those of *Q. Sloteri*, but are not quite equal to them and its chromosome number is half that of *Q. Sloteri*. If the doubling of chromosomes appears in  $F_2$  which is derived from this  $F_1$ , it is not impossible, on the basis of the examples of polyploid plants hitherto reported, that the resultant  $F_2$



Text-fig. 1



Text-fig. 2

Text-figs. 1-2.  $F_1$  *Q. angulata*  $\times$  *Q. pennata*. 1, somatic plate showing 29 chromosomes,  $\times 3500$ ; 2, late diakinesis, about 15 chromosomes are contained,  $\times 2200$ .

or a new constant form might be more or less different in its characters from  $F_1$ . Thus the formation of the species similar to *Q. Sloteri* will not be wholly excluded.

The meiotic chromosomes<sup>(3)</sup> of P.M.C.-s of  $F_1$  as well as of *Quamoclit* species are quite small, though P.M.C.-s are very large. The meiosis proceeds in the same way in  $F_1$ -s in (1) and (2). In

(1) In the study reported in the present paper, the root tips were taken from pots with soil and fixed with FLEMMING's weak solution. They were imbedded in paraffin, cut  $15\mu$  thick and stained with HEIDENHAIN's iron alum haematoxylin.

(2) All text-figs. in the present paper are drawn from  $F_1$ -s formed by different cross combinations of *Q. pennata* with dark "rose red" flowers as the pollen parent, except text-figs. 1 and 4. For them the mixture of  $F_1$ -s was used which were formed by using *Q. pennata* of different flower colours as the pollen parent.

(3) The floral buds were fixed with CARNOY's fluid and BOUIN's solution, imbedded in paraffin, cut  $17-18\mu$  thick and stained with (a) NEWTON's gentian violet and also with (b) HEIDENHAIN's iron alum haematoxylin. The former method of staining gave the better results. All meiotic figures in text are drawn from preparations stained with (a), except the following four: text-figs. 8 and 9, from preparations stained with (b), text-figs. 12 and 14, from uncut materials in BELLING's aceto-carmine.





Text-fig. 3



Text-fig. 4

Text-fig. 5

Text-fig. 6

Text-figs. 3-6.  $F_1$  *Q. angulata*  $\times$  *Q. pennata*. Metaphase or early anaphase of the first division. Side views. Chromosomes drawn in their outline only are the bivalents and those in black the univalents. 3a, a P. M. C. showing 9 bivalents and 11 univalents; 3b, chromosomes of 3a more magnified; 4, 7 bivalents and 15 univalents; 5, 6 bivalents and 17 univalents; 6, 4 bivalents and 21 univalents. 3a  $\times 2200$ , others  $\times 3400$ .

late diakinesis of  $F_1$ , about 15 elements of chromosomes are observed. In certain P.M.C.-s, 14 elements out of 15 are observed to be comparatively large or thick and the remaining one is small or thin (text-fig. 2). These 14 elements may probably be the bivalents formed by allosyndesis between the chromosomes of the two parents, and the remaining one may be an univalent derived from *Q. pennata* which does not find mate. However, the counting and identification of bi- and univalents were not always easy. Besides, in some cases the number of chromosome elements seems to be more or less high, owing probably to the failure of conjugation between certain chromosomes.

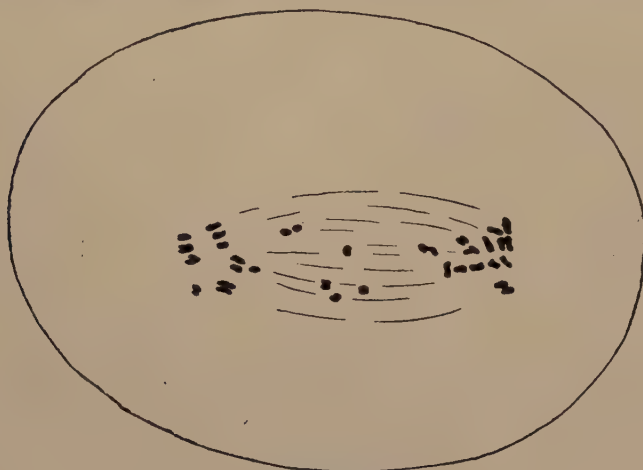
Polar views of the metaphasic plate were not observed. In side views of the first metaphase or very early anaphase, it is shown that the bivalents are located at the equatorial region while the univalents, some of which are the disjoined halves of bivalents, are located nearer the poles. Some of the bivalents disjoin much earlier than others. In text-figs. 3, 4, 5 and 6, respectively 9, 7, 6 and 4 bivalents can be seen. Univalent chromosomes show the splitting with more or less clearness. In these text-figs. most bivalents began to be attracted to the poles and present dumb-bell shape, while others appear as the compact gemini.

The distribution of chromosomes does not take place evenly towards two heterotypic poles. The disjoined halves of bivalents seem to pass often to the same pole without being separated. Occasionally the chromosomes are left behind as lagging chromosomes (text-fig. 7). So that the different numbers of chromosomes are contained in the telophasic nuclei. In the one shown in text-fig. 8, about 14 chromosomes are contained. Often the extra nuclei are formed in heterotypic telophase (text-fig. 9).

In text-fig. 10, two second metaphasic groups of chromosomes can be seen, in one of which 11, and in the other probably 18 chromosomes are contained. In all of them the homotypic split is observable more or less clearly. Text-fig. 11 shows the second late anaphase, in which the extra nucleus is being formed, owing to the irregular distribution of chromosomes.

The production of dyad cells is observed quite frequently in fresh materials in BELLING's aceto-carmin (pl. XIV, 20). The frequency of P.M.C.-s containing them is 13% for (1) (the whole number of P.M.C.-s 409), and 12.8% for (2) (553 P.M.C.-s).

Polyspory occurs very frequently (text-fig. 12), and the highest number of pollen grains formed from one P.M.C. was found in fresh materials treated by BELLING's aceto-carmine to be 13 and 10 in



Text-fig. 7



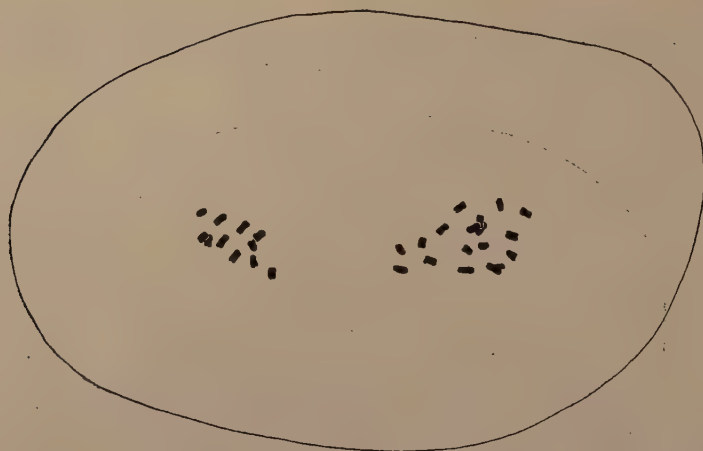
Text-fig. 8



Text-fig. 9

Text-figs. 7-9.  $F_1$  *Q. angulata*  $\times$  *Q. pennata*. 7, late anaphase of the first division showing lagging chromosomes. The chromosomes at two poles are not all drawn,  $\times 2200$ ; 8, first telophasic nucleus containing about 14 chromosomes,  $\times 2550$ ; 9, first telophase showing an extra nucleus,  $\times 1650$ .

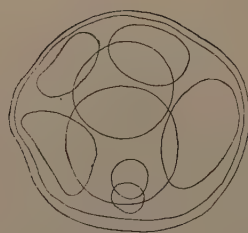
(1) and (2). The size of individual pollen grains differs greatly (pl. XIV, 21).



Text-fig. 10



Text-fig. 11



Text-fig. 12

Text-figs. 10-12.  $F_1$  *Q. angulata*  $\times$  *Q. pennata*. 10, second metaphase,  $\times 2200$ ; 11, second anaphase showing the formation of an extra nucleus. Uppermost group of chromosomes is a polar view in which the chromosomes going to different poles are shown respectively in their outlines only and in black. The chromosomes in other 3 groups present a side view of an irregular second anaphase. All chromosomes are not drawn.  $\times 2200$ ; 12, polyspory,  $\times 400$ .



The dyad cells may contain the somatic number (29) of chromosomes if they were derived from the regular process of the formation of restitution nucleus or non-reduction. If the analogous phenomenon occurs in the female meiosis, the next generation showing  $2n=58$  may be formed as the origin of a new constant species. However, owing to the irregular behaviour of chromosomes, some or most dyad cells may contain different number of chromosomes instead of their regular somatic number, and these dyad cells may probably be more or less abortive. So that the chance of forming  $F_2$  showing  $2n=58$  must be much less than that assumed on the basis of the % value of dyad cell formation above stated.

B. *Q. coccinea*, var. *hederifolia*  $\times$  *Q. pennata* (with dark "rose red" flowers) ..... (3)

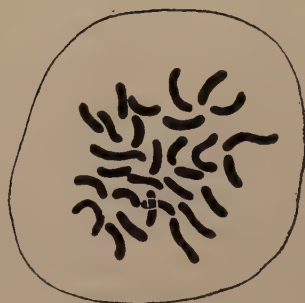
*Q. coccinea*, var. *hederifolia*  $\times$  *Q. pennata* (with white flowers) ..... (4)

The observation was made on 6  $F_1$  plants in (3) and 1  $F_1$  individual of (4). There is no difference regarding the shape of leaves and flowers between (3) and (4). The leaves of these  $F_1$ -s are intermediate in shape between the two parents, and the lobes of leaves are narrower than those of  $F_1$  of A (pl. XIV, 22, 23). The shape and the size of the flowers do not differ much from those of  $F_1$  of A (pl. XV, 24). The flower colour which looks the same to naked eyes in (3) and (4) notwithstanding the difference of flower colour of the paternal parents, is a little darker than that of  $F_1$  of A, and approaches to "rose red." The difference of characters between this  $F_1$  and *Q. Sloteri* is larger than that between the  $F_1$  *Q. angulata*  $\times$  *Q. pennata* and *Q. Sloteri*.

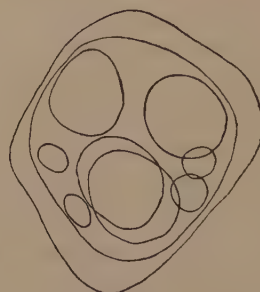
$F_1$  plants showed complete sterility.

The number of somatic chromosomes was counted in root tip cells as 29 (text-fig. 13), the sum of the haploid numbers of the two parents. The formation of dyad cells from P.M.C.-s was observed in the same method as in A (pl. XV, 25). Frequently polyspory occurs (text-fig. 14), and the highest number of pollen grains formed from one P.M.C. is 13 in (3). The size of individual pollen grains differs greatly (pl. XV, 26).

The frequency of forming dyad cells is 4.7% in (3), the whole number of P.M.C.-s being 558. Thus the % value is lower than the corresponding values in  $F_1$  of A, and regarding the contents of dyad



Text-fig. 13



Text-fig. 14

Text-figs. 13-14.  $F_1$  *Q. coccinea*, var. *hederifolia*  $\times$  *Q. pennata*. 13, somatic metaphase presenting 29 chromosomes.  $\times 3500$ ; 14, polyspory,  $\times 400$ .

cells the same may be said as for those in  $F_1$  of A. The chance of producing constant  $F_2$  having the double number of chromosomes may be still smaller than in A. This  $F_1$  is more beautiful than the  $F_1$  of A in its shape of leaves and flower colour, but there is yet no constant form which can be assumed to have arisen from the chromosome doubling of the  $F_1$  made by this combination of parents. In this connection the lower % value of dyad cell formation in this  $F_1$  might possibly have some significance.

#### C. *Q. Sloteri* $\times$ *Q. pennata* (with white flowers).

In this combination of cross, it was very difficult to obtain seeds, and only one  $F_1$  plant was raised. Its leaves are intermediate in shape between the two parents, and their lobes are narrower than those of  $F_1$ -s of A and B (pl. XV, 27, 28). Flower shape is also intermediate between the two parents but nearer to that of *Q. Sloteri* (pl. XV, 29). The colour of flowers is intermediate too and approaches "rose red." This  $F_1$  was also completely sterile, and its pollen grains show great difference in their size (pl. XV, 30).

### Summary

1. The external characters of  $F_1$  *Quamoclit angulata* (*coccinea*) ( $2n=28$ )  $\times$  *Q. pennata* ( $2n=30$ ) lie intermediate between the parents, and resemble those of *Q. Sloteri* ( $2n=58$ ) though not entirely similar, which is said to be a constant hybrid species between

these two species.  $F_1$  *Q. coccinea*, var. *hederifolia* ( $2n = 28$ )  $\times$  *Q. pennata* ( $2n = 30$ ) shows also intermediate characters of the parents.

2. The somatic number of chromosomes in  $F_1$ -s *Q. angulata*  $\times$  *Q. pennata* and *Q. coccinea*, var. *hederifolia*  $\times$  *Q. pennata* is 29, the number corresponding to the sum of the haploid ones of the parents in each cross.

3. In  $F_1$  *Q. angulata*  $\times$  *Q. pennata*, about 15 chromosomes are observed in late diakinesis. They are probably composed of 14 bivalents formed by allosyndesis and one univalent derived from the pollen parent. In some cases the formation of bivalents seems to become less frequent.

4. At the heterotypic metaphase or early anaphase of  $F_1$  *Q. angulata*  $\times$  *Q. pennata* the bivalents as well as the univalents appear, and the poles receive different number of chromosomes. Some chromosomes are left behind as laggards. In homotypic division also their irregular distribution occurs.

5. In  $F_1$ -s *Q. angulata*  $\times$  *Q. pennata* and *Q. coccinea*, var. *hederifolia*  $\times$  *Q. pennata*, the dyad cells are often formed, especially frequently in the former. Polyspory of high degree occurs and the size of pollen grains differs greatly.

6. The possibility of the formation of the new species having the double number of chromosomes is discussed.

This study was aided by a grant to the senior author from the Imperial Academy.

July 1932, UTSUNOMIYA.

---

### Literature cited

- BAILEY, L. H. (1924). Manual of cultivated plants. New York.
- KANO, T. (1929). Cytological studies in Convolvulaceae (Preliminary). (Japanese). Proc. Crop Sci. Soc. Japan. No. 4.
- NAKAJIMA, G. (1931). The chromosome numbers in cultivated and wild angiosperms. Bot. Mag. Tokyo. Vol. 45, No. 529.
- NOHARA, S. (1930). Genetical studies on *Quamoclit*. Journ. Coll. Agr., Imp. Univ. Tokyo. Vol. 11, No. 1.
- RIDGWAY, R. (1912). Color standard and color nomenclature. Washington, D. C.
-



## Explanation of plates XII-XV

On these plates the photographs and photomicrographs of the parents and  $F_1$  hybrids of *Quamoclit* are shown. The number in ( ) in the explanation presents the number of cross described in text. Pollen grains were photographed in lactic acid and the dyad cells from fresh material in BELLING's aceto-carmin.

## PLATE XII

- Fig. 1. *Quamoclit Sloteri*, a leaf.  $\times 65/100$   
 Fig. 2. " " , a seedling.  $\times 85/100$   
 Fig. 3. " " , a flower.  $\times 1/1$   
 Fig. 4. " " , pollen grains.  $\times 14$   
 Fig. 5. *Q. angulata*, a leaf.  $\times 65/100$   
 Fig. 6. " " , a seedling.  $\times 1/1$   
 Fig. 7. " " , a flower.  $\times 1/1$   
 Fig. 8. " " , pollen grains.  $\times 14$

## PLATE XIII

- Fig. 9. *Q. coccinea*, var. *hederifolia*, a leaf.  $\times 65/100$   
 Fig. 10. " " " " , a seedling.  $\times 85/100$   
 Fig. 11. " " " " , a flower.  $\times 1/1$   
 Fig. 12. " " " " , pollen grains.  $\times 14$   
 Fig. 13. *Q. pennata*, a leaf.  $\times 65/100$   
 Fig. 14. " " , a seedling.  $\times 1/1$   
 Fig. 15. " " two flowers, dark "rose red" and white.  $\times 1/1$   
 Fig. 16. " " , pollen grains.  $\times 14$

## PLATE XIV

- Fig. 17.  $F_1$  *Q. angulata*  $\times$  *Q. pennata*, a leaf. (1).  $\times 65/100$   
 Fig. 18. " " " " , two seedlings. (2).  $\times 85/100$   
 Fig. 19. " " " " , a flower. (2).  $\times 1/1$   
 Fig. 20. " " " " , dyad cells. (2).  $\times 110$   
 Fig. 21. " " " " , pollen grains. (1).  $\times 14$   
 Fig. 22.  $F_1$  *Q. coccinea*, var. *hederifolia*  $\times$  *Q. pennata*, a leaf. (3).  $\times 65/100$ .  
 Fig. 23. " " " " " " , a seedling. (3).  $\times 85/100$

## PLATE XV

- Fig. 24.  $F_1$  *Q. coccinea*, var. *hederifolia*  $\times$  *Q. pennata*, a flower. (3).  $\times 1/1$   
 Fig. 25. " " " " " " , dyad cells. (3).  $\times 110$   
 Fig. 26. " " " " " " , pollen grains. (3).  $\times 14$   
 Fig. 27.  $F_1$  *Q. Sloteri*  $\times$  *Q. pennata*, a leaf.  $\times 1/1$   
 Fig. 28. " " " " , a seedling.  $\times 85/100$   
 Fig. 29. " " " " , a flower.  $\times 1/1$   
 Fig. 30. " " " " , pollen grains.  $\times 14$ .

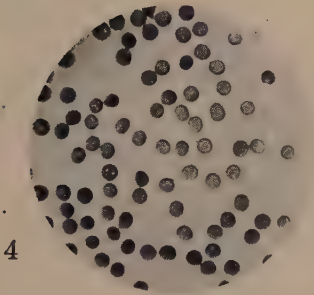




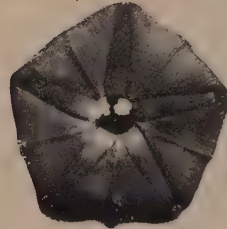
1



2



4



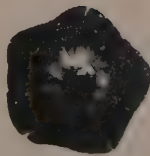
3



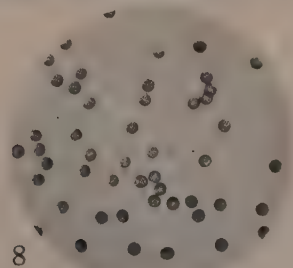
6



5



7



8



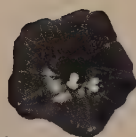




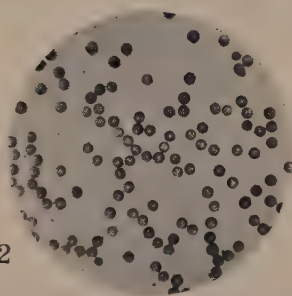
9



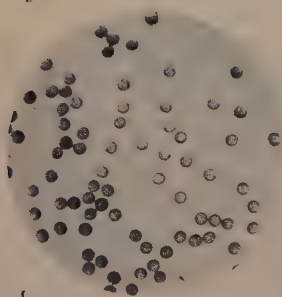
10



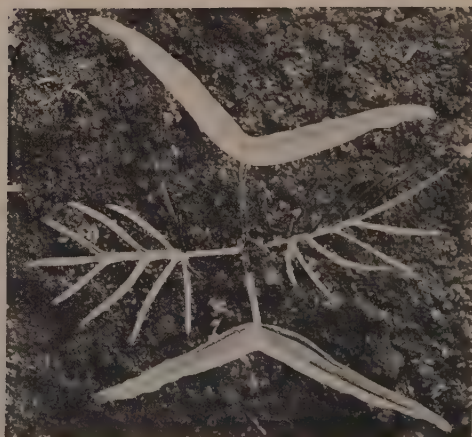
11



12



16



14



13



15



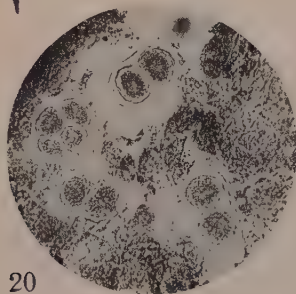


19

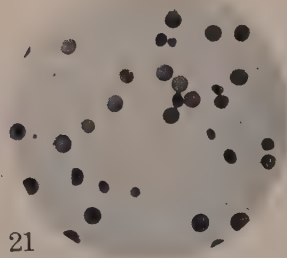
17



18



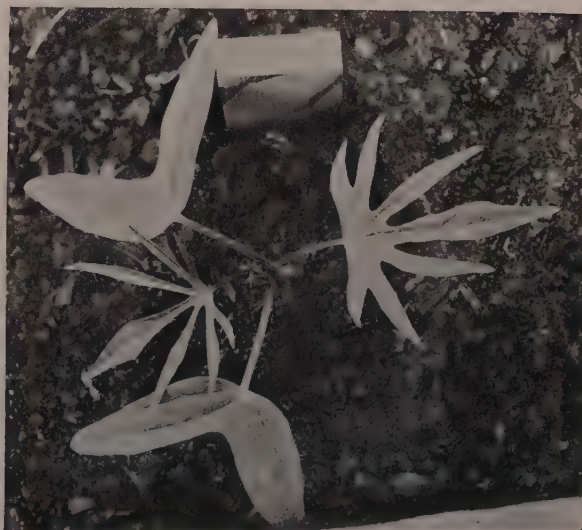
20



21



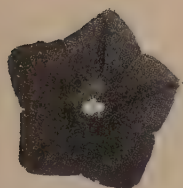
22



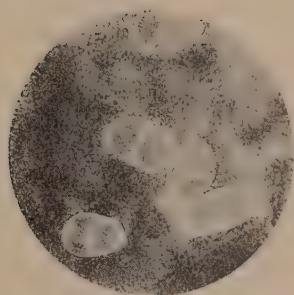
23







24



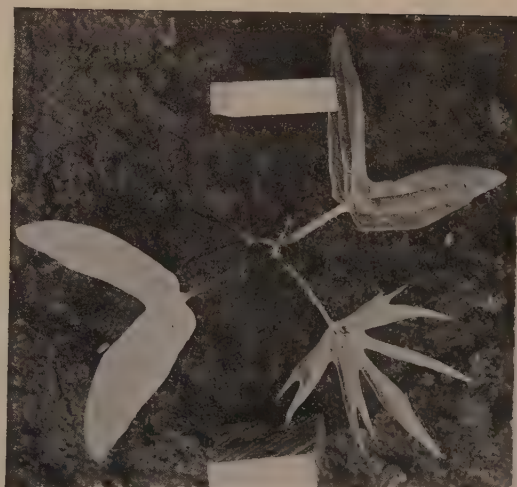
25



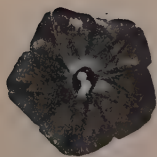
26



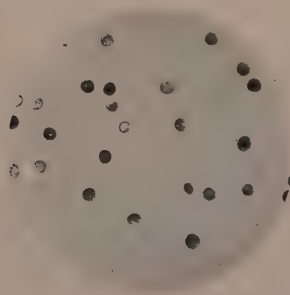
27



28



29



30



# Studies on *Uromyces Fabae* and its related species

By Naohide HIRATSUKA

With plates XVI-XVII

(Received November 19, 1932)

## Contents

	Page
Introduction . . . . .	330
Comparative morphology of <i>Uromyces Fabae</i> and its related species . .	330
Experimental methods and materials. . . . .	331
Aecidial stage. . . . .	333
Uredostage . . . . .	336
Teleutostage . . . . .	339
Conclusions and taxonomic considerations . . . . .	344
Biology of <i>Uromyces Fabae</i> , <i>U. Orobi</i> and <i>U. Ervi</i> . . . . .	349
Inoculation experiments with <i>Uromyces Fabae</i> , <i>U. Orobi</i> and <i>U. Ervi</i>	350
<i>Uromyces Fabae</i> . . . . .	350
1. Inoculations with the uredospores on <i>Vicia Faba</i> . . . . .	350
2. Inoculations with the uredospores on <i>Pisum sativum</i> . . . .	353
3. Inoculations with the aecidiospores on <i>Pisum sativum</i> . . . .	353
4. Inoculations with the uredospores on <i>Lathyrus maritimus</i>	354
5. Conclusions . . . . .	355
<i>Uromyces Orobi</i> . . . . .	356
1. Inoculations with the aecidiospores on <i>Vicia nipponica</i> var.	
<i>capitata</i> . . . . .	356
2. Inoculations with the uredospores on <i>Vicia nipponica</i> var.	
<i>capitata</i> . . . . .	357
3. Inoculations with the uredospores on <i>Vicia unijuga</i> . . . .	358
4. Conclusions . . . . .	359
<i>Uromyces Ervi</i> . . . . .	359
1. Inoculations with the aecidiospores on <i>Vicia hirsuta</i> . . . .	359
2. Inoculations with the uredospores on <i>Vicia hirsuta</i> . . . .	360
3. Inoculations with the aecidiospores on <i>Vicia sativa</i> . . . .	361
4. Inoculations with the uredospores on <i>Vicia sativa</i> . . . .	362
5. Inoculations with the aecidiospores on <i>Vicia tetrasperma</i> . .	362
6. Inoculations with the uredospores on <i>Vicia tetrasperma</i> . .	362
7. Conclusions . . . . .	362

Repeating aecidia of <i>Uromyces Ervi</i> . . . . .	363
Experiment 1 . . . . .	363
Experiment 2 . . . . .	363
Experiment 3 . . . . .	364
Conclusions . . . . .	364
Geographical distribution and host plants of <i>Uromyces Fabae</i> , <i>U. Orobi</i> and <i>U. Ervi</i> in Japan . . . . .	365
<i>Uromyces Fabae</i> (PERS.) DE BARY . . . . .	365
<i>Uromyces Orobi</i> (PERS.) LÉV. . . . .	371
<i>Uromyces Ervi</i> (WALLR.) WEST. . . . .	372
General summary . . . . .	375
Literature cited . . . . .	377
Explanation of plates XVI-XVII. . . . .	379
Plates XVI-XVII . . . . .	

## Introduction

It is well known that a rust caused by *Uromyces Fabae* (PERS.) DE BARY is very injurious to broad bean (*Vicia Faba* L.) and that it occurs throughout the world wherever the host plant is cultivated. *Uromyces Fabae* is a collective species which is parasitic on many different species of *Vicia*, *Lathyrus* and *Pisum* of the Viciaeae belonging to the family Leguminosae. Two other species, closely related to *Uromyces Fabae* have been described: *Uromyces Orobi* (PERS.) LÉV. and *U. Ervi* (WALLR.) WEST. occurring on a certain species of *Vicia* and *Lathyrus* from Europe. All these species also have been recorded from our country.

From several years ago, the writer has been studying the comparative morphology and biology of *Uromyces Fabae* and its related species, and a part of his experimental data has already been published as preliminary reports in Japanese. The present paper presents these experimental data of his investigations.

## Comparative morphology of *Uromyces Fabae* and its related species

The present experiments deal with comparative studies on the morphology of *Uromyces Fabae* and its related species on various



leguminous plants, which were collected in our country. The Japanese species of Leguminosae which are affected by *Uromyces Fabae* and its related species, examined in the experiments, are thirteen in number. They are: *Vicia amoena* FISCH. var. *sachalinensis* FR. SCHM., *V. Cracca* L. var. *japonica* MIQ., *V. Faba* L., *V. hirsuta* KOCH, *V. japonica* A. GRAY, *V. nipponica* MATSUM. var. *capitata* NAKAI, *V. sativa* L., *V. tetrasperma* MOENCH., *V. unijuga* A. BR., *Lathyrus Davidii* HANCE, *L. maritimus* (L.) BIGEL, *L. palustris* L. var. *lineae-folius* SER. and *Pisum sativum* L. All these plants belong to the Viciae of the family Leguminosae.

### Experimental methods and materials

For general observations under microscope, distilled water or a 0.5% solution of KOH or NaOH was used in the spore mounts. When the spores were fresh, distilled water was used; when they were dried specimens, the solution of KOH or NaOH was employed. For counting the number of germ pores in uredospores, lactic acid or blue lacto-phenol recommended by CUNNINGHAM (4) (1) was employed as mounting fluid.

In the spore measurements, one or two hundred spores from each material chosen were measured at one time using a Zeiss eye piece micrometer, and the length, width and wall-thickness of each was recorded separately. Unconscious selection of spores for measurement was avoided by measuring all the spores which were encountered in moving across the field of vision systematically by means of a mechanical stage. In measuring the spores, the statistical constants were calculated by the assumed mean method. The formulae used were as follows:—Mean:  $M = G + m$ , Average deviation:

$$m = \frac{\sum_p(A-G)}{n}, \text{ Standard deviation: } \delta = \sqrt{\frac{\sum_p(A-G)^2}{n} - m^2},$$

$$\text{Probable error of } M: E_M = \pm 0.6745 \frac{\delta}{\sqrt{n}} \text{ and Probable error of } \delta:$$

$$E_\delta = \pm 0.6745 \frac{\delta}{\sqrt{2n}}. \text{ In these formulae, } p \text{ represents the frequency, } A \text{ the value of each variate, } G \text{ the mode of the population, and } n \text{ the total number of the frequency.}$$

For the experiments, the writer used the materials shown in Table 1.

---

(1) Reference is made by number to "Literature cited" (p. 377).

TABLE 1. Materials used for the morphological studies of *Uromyces Fabae* and its related species

Material no.	Host plants	Locality of collection	Date of collection	Collector	Stage of the fungus
V-1a	<i>Vicia amoena</i> var. <i>sachalinensis</i>	Numanohata, Prov. Iburi	3/IX, 1926	N. HIRATSUKA	III
V-2a	<i>V. Cracca</i> var. <i>japonica</i>	Mt. Moiwa, Prov. Ishikari	10/X, 1922	" KAWAI	II, III
V-2b	"	Urimakku, Prov. Tokachi	29/IX, 1929	"	II, III
V-2c	"	Mt. Moiwa, Prov. Ishikari	23/X, 1924	N. HIRATSUKA	III
V-3a	<i>Vicia Fabae</i>	Tottori, Prov. Inaba	29/V, 1930	N. HIRATSUKA & M. YOSHIDA	II, III
V-3b	"	"	24/V, 1930	"	II, III
V-3c	"	Kagoshima, Prov. Satsuma	1/VII, 1930	N. HIRATSUKA	III
V-3d	"	Nagaoka-mura, Prov. Tosa	18/V, 1931	T. NAITÔ	II, III
V-3e	"	Kotoni-mura, Prov. Tosa	5/VI, 1931	H. ASUYAMA	II, III
V-3f	"	Kurashiki, Prov. Bitchû	5/VIII, 1929	S. IWADARE	II, III
V-3g	"	Miyazaki, Prov. Hingû	25/V, 1930	Y. UEMURA	II, III
V-3h	"	Omokage-mura, Prov. Inaba	3/VII, 1930	T. KATÔ	II, III
V-4a	<i>Vicia hirsuta</i>	Tottori, Prov. Inaba	29/V, 1930	M. YOSHIDA	I, II, III
V-4b	"	"	3/V, 1931	N. HIRATSUKA	I, II, III
V-4c	"	"	17/IV, 1931	"	I, II, III
V-5a	<i>Vicia japonica</i>	Wakkanai, Prov. Kitami	15/X, 1923	K. TOGASHI & N. HIRATSUKA	III
V-5b	"	Akashiki, S. Saghalien	31/VIII, 1929	Y. TOKUNAGA & K. KAWAI	II, III
V-6a	<i>Vicia nipponica</i> var. <i>capitata</i>	Ubeno-mura, Prov. Inaba	27/XI, 1929	N. HIRATSUKA & M. YOSHIDA	II, III
V-6b	"	"	22/V, 1930	"	I
V-6c	"	"	4/VI, 1930	M. YOSHIDA	II
V-6d	"	"	5/XI, 1929	"	II, III
V-7a	<i>Vicia sativa</i>	Omokage-mura, Prov. Inaba	24/V, 1930	N. HIRATSUKA & M. YOSHIDA	I, II, III
V-7b	"	Tottori, Prov. Inaba	20/V, 1930	M. YOSHIDA	I, II, III
V-8a	<i>Vicia tetrasperma</i>	Ubeno-mura, Prov. Inaba	19/V, 1930	N. HIRATSUKA	I, II, III
V-9a	<i>V. unijuga</i>	"	4/VI, 1930	N. HIRATSUKA & M. YOSHIDA	I, II
V-9b	"	"	1/XII, 1929	"	II, III
V-9c	"	"	27/XI, 1929	"	II, III
L-1a	<i>Lathyrus Davidii</i>	Mt. Ibuki, Prov. Ômi	17/X, 1925	K. TOGASHI	II, III
L-2a	<i>L. maritimus</i>	Fukube-mura, Prov. Inaba	4/XI, 1929	N. HIRATSUKA	II, III
L-2b	"	Nakanogô-mura, Prov. Inaba	14/V, 1930	N. HIRATSUKA & M. YOSHIDA	I, II
L-2c	"	Seto, Prov. Kii	21/V, 1930	M. YOSHIDA	I, II
L-2d	"	Horomui, Prov. Ishikari	23/XII, 1931	Y. HASHIOKA	II, III
L-3a	<i>Lathyrus palustris</i> var. <i>lineaeifolius</i>	Kuriyagawa, Morioka, Prov. Rikuchû	30/X, 1929	K. KAWAI & M. SAKAMOTO	II, III
L-3b	"	Omokage-mura, Prov. Inaba	12/VIII, 1929	F. ÔNUMA	II, III
P-1a	<i>Pisum sativum</i>	"	3/VI, 1930	M. YOSHIDA	II, III
P-1b	"	"	28/V, 1930	"	II, III
P-1c	"	Ubeno-mura, Prov. Inaba	4/VI, 1930	N. HIRATSUKA & M. YOSHIDA	I, II, III
P-1d	"	Seijô-mura, Prov. Inaba	8/VII, 1930	N. HIRATSUKA	I, II, III

### Aecidial stage

As shown in Table 1, the aecidial stage of the fungi was examined on *Vicia hirsuta* (V-4a, b), *V. nipponica* var. *capitata* (V-6b), *V. sativa* (V-7a, b), *V. tetrasperma* (V-8a), *V. unijuga* (V-9a), *Lathyrus maritimus* (L-2b, c) and *Pisum sativum* (P-1c, d).

**Spermogonia**—Spermogonia on *Lathyrus maritimus* (L-2b, c) are usually epiphyllous, small and numerous. They are subepidermal and hemispherical, measuring 110 to 140  $\mu$  broad by 40–70  $\mu$  high. The spermatia are minute, ellipsoidal and measure approximately 1–3  $\mu$  in diameter. Ostiolar filaments develop well.

Spermogonia of the fungus on *Pisum sativum* (P-1c) are mostly epiphyllous and subepidermal. They are small and hemispherical in shape, and measure 90–130  $\mu$  broad by 35–60  $\mu$  high. The spermatia are ellipsoidal, 1.2–4  $\mu$  in diameter. Ostiolar filaments develop rather well.

In the fungus on *Vicia nipponica* var. *capitata* (V-6b), spermogonia occur on the upper surface of leaves and stems, preceding development of aecidia. They are subepidermal and hemispherical or somewhat flask-shaped, measuring 110–150  $\mu$  in diameter and 50–68  $\mu$  in height. The spermatia are subglobose to ellipsoidal, 1.2–3  $\mu$  across, and ostiolar filaments develop well.

In the materials of the fungus on *Vicia unijuga* (V-9a), it was not possible to examine its spermogonia sufficiently, because they had already devoided. On specimens of *Vicia hirsuta* (V-4a, b), *V. sativa* (V-7a, b) and *V. tetrasperma* (V-8a), many aecidia were found, while no spermogonia were observed, except on a specimen of *Vicia hirsuta* (V-4c). A few spermogonia were found on a specimen of *Vicia hirsuta* which was collected in Tottori on April 17, 1931. They are formed under the epidermis of the upper surface of leaf or on stems, and are flask-shaped, measuring 90–120  $\mu$  broad, 56–70  $\mu$  high. The spermatia are minute and ovate to ellipsoidal in shape, 1.5–3  $\mu$  across, and ostiolar filaments are more or less developed.

Some records on spermogonia of *Uromyces Fabae* and its related species have been made by certain authorities. In their monograph, the SYDOWS(32) wrote briefly; "Pycnidiis hypophyllis, inter evolutis" in the descriptions of *Uromyces Fabae* and *Uromyces Orobi*, while no description of spermogonia of *Uromyces Ervi* was given. In 1912, ARTHUR(1) described the spermogonial stage of *Uromyces*

*Fabae* in detail as follows: "O. Pycnia chiefly epiphyllous, in small groups about 0.5 mm. across, few, inconspicuous, honey-yellow, globose, 98–130  $\mu$  in diameter by 80–115  $\mu$  high; ostiolar filaments 40–55  $\mu$  long." In the next year, KLEBAHN (27) reported spermogonia of *Uromyces Orobi* as: "Spermogonien unter der Epidermis entstehend, eingesenkt, oberer Teil kegelförmig vorragend." As far as the writer knows, the spermogonial stage of *Uromyces Ervi* has never been described up to the present.

**Aecidia**—In general appearance the aecidia resemble each other, but some differences exist among these fungi on different hosts. In the fungi on *Pisum sativum*, *Lathyrus maritimus*, *Vicia nipponica* var. *capitata* and *V. unijuga*, the aecidia are hypophyllous as well as epiphyllous, occasionally on stems or pods, usually in company with spermogonia. In a specimen on *Vicia nipponica* var. *capitata* (V-6b), a considerable number of aecidia occur, especially on the stems.

Aecidia on *Pisum sativum* are mostly hypophyllous and are either scattered or in small roundish or elongated groups, 1–1.8 mm. across, cupulate. The margin of pseudoperidia is lacerate and somewhat revolute. The peridial cells are rhomboidal, 24–32  $\mu$  long, with their outer wall transversely striate and rather thick (6–9  $\mu$ ), and the inner one verrucose and thinner (2–4  $\mu$ ). The aecidiospores are globose, ovate to ellipsoidal, sometimes somewhat angular, and measure  $23.46 \pm 0.12 \mu$  by  $20.58 \pm 0.11 \mu$ , with wall 1–1.8  $\mu$  in thickness and finely verrucose. The essential characters of aecidia on *Lathyrus maritimus*, *Vicia nipponica* var. *capitata* and *V. unijuga* agree with those on *Pisum sativum*, as stated above.

The fungi on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* closely resemble each other in the essential characters of aecidia. They are produced on both surfaces of leaves, petioles or on stems, mostly without accompanying spermogonia. They are in small groups or sometimes scattered, light yellow in colour and cupulate. The margin of pseudoperidia is lacerate and revolute. The peridial cells are rhomboidal, 20–28  $\mu$  long, the exterior wall of the cell is striate and 5–6  $\mu$  thick, while the inner one is verrucose and thinner (2–3  $\mu$  thick). The aecidiospores are globose or ellipsoidal, rarely somewhat angular and densely verrucose, measuring  $20.55 \pm 0.11 - 21.15 \pm 0.11 \times 17.79 \pm 0.11 - 18.18 \pm 0.07 \mu$ , with wall 1–1.5  $\mu$  in thickness. (Pl. XVII, fig. 1).

From the preceding examinations, it is clear that the aecidiospores on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* are smaller in



size than those on other plants, while no remarkable difference in other characters can be found between them. The results of measurement of aecidiospores on different hosts are shown in Tables 2 and 3 in detail.

As far as the writer is aware, aecidia on *Vicia Faba* have never been observed in our country. PLOWRIGHT (30) asserted that he had produced aecidia in one case experimentally on *Vicia Faba* by inoculating with sporidia from its teleutospores; but so far as the writer knows, that is the only record of aecidia on *Vicia Faba*. Moreover, the writer has never obtained any Japanese specimens of this stage on *Lathyrus Davidii*, *L. palustris* var. *lineaeifolius*, *Vicia amoena* var. *sachalinensis*, *V. Cracca* var. *japonica* and *V. japonica*, and also he is not aware that they have been recorded in our country; but they will probably be found if searched for carefully.

TABLE 2  
Biometric data for length of aecidiospores of *Uromyces Fabae*  
and its related species (in  $\mu$ )

Material no.	Host plants	Range	Mode	Mean	Standard deviation
P-1c	<i>Pisum sativum</i>	21-27	24	23.46 $\pm$ 0.13	1.90 $\pm$ 0.09
L-2c	<i>Lathyrus maritimus</i>	21-27	24	24.30 $\pm$ 0.13	1.90 $\pm$ 0.09
V-6b	<i>Vicia nipponica</i> v. <i>capitata</i>	18-27	24	24.36 $\pm$ 0.16	2.34 $\pm$ 0.10
V-9a	<i>V. unijuga</i>	21-30	24	24.84 $\pm$ 0.08	1.24 $\pm$ 0.06
V-4a	<i>V. hirsuta</i>	18-24	21	20.55 $\pm$ 0.11	1.60 $\pm$ 0.08
V-7a	<i>V. sativa</i>	21-24	21	21.15 $\pm$ 0.11	1.59 $\pm$ 0.08
V-8a	<i>V. tetrasperma</i>	18-24	21	21.06 $\pm$ 0.09	1.40 $\pm$ 0.07

TABLE 3  
Biometric data for width of aecidiospores of *Uromyces Fabae*  
and its related species (in  $\mu$ )

Material no.	Host plants	Range	Mode	Mean	Standard deviation
P-1c	<i>Pisum sativum</i>	18-24	21	20.58 $\pm$ 0.11	1.62 $\pm$ 0.08
L-2c	<i>Lathyrus maritimus</i>	18-24	21	21.33 $\pm$ 0.11	1.61 $\pm$ 0.08
V-6b	<i>Vicia nipponica</i> v. <i>capitata</i>	18-24	21	21.06 $\pm$ 0.14	2.08 $\pm$ 0.10
V-9a	<i>V. unijuga</i>	18-24	21	22.23 $\pm$ 0.03	0.50 $\pm$ 0.02
V-4a	<i>V. hirsuta</i>	15-21	18	17.79 $\pm$ 0.11	1.63 $\pm$ 0.08
V-7a	<i>V. sativa</i>	15-21	18	18.18 $\pm$ 0.07	1.24 $\pm$ 0.05
V-8a	<i>V. tetrasperma</i>	15-21	18	17.91 $\pm$ 0.09	1.37 $\pm$ 0.07

### Uredostage

Uredosori on different hosts are mostly produced on leaves, occasionally on petioles or stems. But some differences of the characters of sori can be found macroscopically in a certain group of these fungi.

The uredosori of the fungi on *Vicia Faba* (V-3a, b, d-h) (Pl. XVI, figs. 1, 3, 4-6), *V. Cracca* var. *japonica* (V-2a, b), *V. japonica* (V-5b), *Lathyrus maritimus* (L-2a-d), *L. palustris* var. *lineaefolius* (L-3a, b) and *Pisum sativum* (P-1a-d) occur on both sides of leaves or chiefly on the under surface, and also on the stems, petioles and pods. They are produced under the epidermis, which is soon ruptured thus exposing the spores. The sori are round or oblong, scattered or clustered on the leaves, sometimes in circular groups up to 4.5 mm. in diameter, and elongated on the stems, powdery, prominent, and brown in colour. The essential characters of the fungi on these plants agree with those on the other plants. But some differences can be found macroscopically among them in the colour and position of the sori.

Those on *Vicia nipponica* var. *capitata* (V-6a, c, d) and *V. unijuga* (V-8a-c) are most abundantly produced on the upper surface, and are brownish yellow in colour. As to the fungi on *Lathyrus Davidii*, sori occur generally on the under surface of leaves, not on the upper one, and they are brownish yellow in colour like those on *Vicia nipponica* var. *capitata* or *V. unijuga*. As to the fungi on *Vicia hirsuta* (V-4a, b), *V. sativa* (V-7a, b) and *V. tetrasperma* (V-8a), sori are produced on both surfaces of leaves, especially on the upper one, and are pale brownish coloured. Moreover, it is of interest that the development of uredosori on the latter three plants is rather poor though aecidia and teleutosori are abundantly formed on the same host plant. This fact will be discussed in a later chapter.

The uredospores on different hosts resemble each other in shape, being globose, ovate or ellipsoidal. But, there are some notable differences among the spores on different hosts in size and wall-thickness as well as in the number and position of germ pores.

The uredospores on ten of the different plants studied, excepting those on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*, closely resemble each other in size and the number of germ pores. They measure  $25.41 \pm 0.03 - 28.50 \pm 0.01 \mu$  in length,  $21.60 \pm 0.09 - 24.02$

$\pm 0.09 \mu$  in width, and they have 3 to 5 germ pores, which are scattered over the surface of the spores. Among them, however, the spores on *Vicia nipponica* var. *capitata*, *V. unijuga* and *Lathyrus Davidii* are more or less larger and those on *Pisum sativum* (P-1c) and *Vicia Cracca* var. *japonica* are somewhat smaller than those on the others. (Pl. XVII, figs. 2, 3).

The spores on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* (Pl. XVII, fig. 4) are remarkably smaller than those on the other ten plants, measuring  $24.35 \pm 0.12 - 25.37 \pm 0.17 \times 20.85 \pm 0.09 - 21.56 \pm 0.09 \mu$ , and they have two germ pores on their equatorial portion. The germ pores of the spores are often seen in the untreated spores, but they are clearly visible after treatment with lactic acid.

The walls of uredospores on *Lathyrus Davidii* are distinctly thick ( $2-3.5 \mu$ ) and those on *Vicia nipponica* var. *capitata* and *V. unijuga* are more or less thicker ( $1.5-3 \mu$ ) than those on the spores from other plants ( $1.2-2.25 \mu$ ). Germ pores and wall-thickness of uredospores will be discussed in detail in a later paragraph.

The echinulations on the uredospores on each different host are indistinguishable from each other.

The results of the measurements of the uredospores on different plants have been tabulated in Tables 4, 5 and 6.

TABLE 4  
Biometric data for length of uredospores of *Uromyces Fabae* and its related species (in  $\mu$ )

Material no.	Host plants	Range	Mode	Mean	Standard deviation
V-6c	<i>Vicia nipponica</i> v. <i>capitata</i>	24-33	27	$28.50 \pm 0.01$	$0.16 \pm 0.01$
V-9b	<i>V. unijuga</i>	24-33	27	$27.76 \pm 0.07$	$1.38 \pm 0.05$
L-1a	<i>Lathyrus Davidii</i>	24-36	27	$27.81 \pm 0.11$	$1.65 \pm 0.07$
L-2b	<i>L. maritimus</i>	24-33	27	$27.69 \pm 0.12$	$1.71 \pm 0.08$
L-2c	"	24-33	27	$27.69 \pm 0.10$	$2.18 \pm 0.07$
V-3f	<i>Vicia Faba</i>	24-33	27	$27.75 \pm 0.11$	$1.70 \pm 0.08$
V-3g	"	24-33	27	$27.50 \pm 0.08$	$1.77 \pm 0.06$
V-3b	"	24-33	27	$27.47 \pm 0.08$	$1.74 \pm 0.06$
V-3a	"	24-30	27	$27.42 \pm 0.09$	$1.99 \pm 0.07$
P-1a	<i>Pisum sativum</i>	21-33	27	$27.44 \pm 0.09$	$1.86 \pm 0.06$
P-1b	"	24-33	27	$27.21 \pm 0.14$	$2.01 \pm 0.10$
V-5b	<i>Vicia japonica</i>	21-30	27	$26.34 \pm 0.10$	$1.51 \pm 0.07$
P-1c	<i>Pisum sativum</i>	21-30	27	$25.62 \pm 0.11$	$2.16 \pm 0.07$
V-2a	<i>Vicia Cracca</i> var. <i>japonica</i>	21-30	27	$25.41 \pm 0.03$	$0.43 \pm 0.02$
L-3b	<i>Lathyrus palustris</i> var. <i>lineaeifolius</i>	21-30	27	$25.68 \pm 0.03$	$0.46 \pm 0.02$
V-4a	<i>Vicia hirsuta</i>	21-30	24	$25.37 \pm 0.17$	$2.39 \pm 0.08$
V-4b	"	21-30	24	$25.12 \pm 0.11$	$2.16 \pm 0.07$
V-7b	<i>Vicia sativa</i>	21-33	24	$25.15 \pm 0.11$	$2.23 \pm 0.08$
V-8a	<i>V. tetrasperma</i>	18-30	24	$24.35 \pm 0.12$	$2.46 \pm 0.08$

TABLE 5  
Biometric data for width of uredospores of *Uromyces*  
*Fabae* and its related species (in  $\mu$ )

Material no.	Host plants	Range	Mode	Mean	Standard deviation
V-6c	<i>Vicia nipponica</i> v. <i>capitata</i>	21-27	24	23.34 $\pm$ 0.06	1.29 $\pm$ 0.04
V-9b	<i>V. unijuga</i>	21-27	24	24.02 $\pm$ 0.09	1.89 $\pm$ 0.06
L-1a	<i>Lathyrus Davidii</i>	18-27	24	23.85 $\pm$ 0.13	1.90 $\pm$ 0.09
L-2b	<i>L. maritimus</i>	21-27	24	23.55 $\pm$ 0.09	1.30 $\pm$ 0.09
L-2c	" "	21-27	21	22.85 $\pm$ 0.14	2.98 $\pm$ 0.10
V-3f	<i>Vicia Faba</i>	21-27	24	23.82 $\pm$ 0.12	1.72 $\pm$ 0.08
V-3g	" "	21-27	24	23.96 $\pm$ 0.05	0.97 $\pm$ 0.04
V-3b	" "	21-27	24	23.84 $\pm$ 0.06	1.23 $\pm$ 0.04
V-3a	" "	21-27	24	23.31 $\pm$ 0.05	0.98 $\pm$ 0.03
P-1a	<i>Pisum sativum</i>	21-27	24	23.93 $\pm$ 0.06	1.32 $\pm$ 0.04
P-1b	" "	21-27	24	23.94 $\pm$ 0.10	1.53 $\pm$ 0.07
V-5b	<i>Vicia japonica</i>	18-27	21	22.65 $\pm$ 0.04	0.56 $\pm$ 0.03
P-1c	<i>Pisum sativum</i>	18-24	21	21.81 $\pm$ 0.06	1.24 $\pm$ 0.04
V-2a	<i>Vicia Cracca</i> var. <i>japonica</i>	18-24	21	21.60 $\pm$ 0.09	1.28 $\pm$ 0.06
L-3b	<i>Lathyrus palustris</i> var. <i>lineaeifolius</i>	21-27	21	22.26 $\pm$ 0.03	0.45 $\pm$ 0.02
V-4a	<i>Vicia hirsuta</i>	18-24	21	21.56 $\pm$ 0.09	1.51 $\pm$ 0.05
V-4b	" "	18-24	21	21.23 $\pm$ 0.09	1.38 $\pm$ 0.07
V-7b	<i>Vicia sativa</i>	18-27	21	21.21 $\pm$ 0.07	1.47 $\pm$ 0.05
V-8a	<i>V. tetrasperma</i>	18-24	21	20.85 $\pm$ 0.09	1.64 $\pm$ 0.06

TABLE 6  
Wall-thickness and number of germ pores of uredospores  
of *Uromyces Fabae* and its related species

Material no.	Host plants	Wall-thickness (in $\mu$ )	Number of germ pores
V-6c	<i>Vicia nipponica</i> var. <i>capitata</i>	1.8-3	3-5
V-9b	<i>V. unijuga</i>	1.5-3	3-4 (5)
L-1a	<i>Lathyrus Davidii</i>	2-3.5	3-4
L-2b	<i>L. maritimus</i>	1.5-2.5	3-4
V-2c	" "	1.5-2.25	3-4 (5)
V-3f	<i>Vicia Faba</i>	1.5-2.25	3-5
V-3g	" "	1.5-2.25	3-4 (5)
V-3b	" "	1.5-2.25	3-4
V-3a	" "	1.5-2.25	3-4
P-1a	<i>Pisum sativum</i>	1.5-2.25	3-4
P-1b	" "	1.5-2.25	3-4
V-5b	<i>Vicia japonica</i>	1.5-2.25	3-4
P-1c	<i>Pisum sativum</i>	1.5-2.25	3-4
V-2a	<i>Vicia Cracca</i> var. <i>japonica</i>	1.5-2.5	3-4
V-3b	<i>Lathyrus palustris</i> var. <i>lineaeifolius</i>	1.5-2.25	3-4
V-4a	<i>Vicia hirsuta</i>	1.2-2.25	2
V-4b	" "	1.2-2.25	2
V-7b	<i>Vicia sativa</i>	1.2-2.25	2
V-8a	<i>V. tetrasperma</i>	1.2-2.25	2

The experimental data shown in Tables 4, 5 and 6 are summarized as below.



TABLE 7  
Summary of measurement of uredospores of *Uromyces Fabae* and its related species

Host plants	Material no.	Length (in $\mu$ )	Width (in $\mu$ )	Wall-thickness (in $\mu$ )	Number of germ pores
<i>Vicia nipponica</i> v. <i>capitata</i>	V-6c	$28.50 \pm 0.01$	$23.34 \pm 0.06$	1.8-3	3-5
<i>V. unijuga</i>	V-9b	$27.75 \pm 0.07$	$24.02 \pm 0.09$	1.5-3	3-4(5)
<i>Lathyrus Davidii</i>	L-1a	$27.81 \pm 0.11$	$23.85 \pm 0.13$	2-3.5	3-4
<i>L. maritimus</i>	{L-2b	$27.69 \pm 0.12$	$23.55 \pm 0.09$	1.5-2.5	3-4
	{L-2c	$27.69 \pm 0.10$	$22.85 \pm 0.14$	1.5-2.25	3-4(5)
<i>Vicia Faba</i>	{V-3f	$27.75 \pm 0.11$	$23.82 \pm 0.12$	1.5-2.25	3-5
	{V-3g	$27.50 \pm 0.08$	$23.96 \pm 0.05$	1.5-2.25	3-4
	{V-3b	$27.47 \pm 0.08$	$23.84 \pm 0.06$	1.5-2.25	3-4(5)
	{V-3a	$27.42 \pm 0.09$	$23.31 \pm 0.05$	1.5-2.25	3-4
<i>Pisum sativum</i>	{P-1a	$27.44 \pm 0.09$	$23.93 \pm 0.06$	1.5-2.25	3-4
	{P-1b	$27.21 \pm 0.14$	$23.94 \pm 0.10$	1.5-2.25	3-4
<i>Vicia japonica</i>	V-5b	$26.34 \pm 0.10$	$22.65 \pm 0.04$	1.5-2.25	3-4
<i>Pisum sativum</i>	P-1c	$25.65 \pm 0.11$	$21.81 \pm 0.06$	1.5-2.25	3-4
<i>Vicia Cracca</i> v. <i>japonica</i>	V-2a	$25.41 \pm 0.03$	$21.60 \pm 0.09$	1.5-2.25	3-4
<i>Lathyrus palustris</i> v. <i>lineaeifolius</i>	L-3b	$25.68 \pm 0.03$	$22.26 \pm 0.03$	1.5-2.25	3-4
<i>Vicia hirsuta</i>	{V-4a	$25.37 \pm 0.17$	$21.56 \pm 0.09$	1.2-2.25	2
	{V-4b	$25.12 \pm 0.11$	$21.23 \pm 0.09$	1.2-2.25	2
<i>V. sativa</i>	V-7b	$25.15 \pm 0.11$	$21.21 \pm 0.07$	1.2-2.25	2
<i>V. tetrasperma</i>	V-8a	$24.35 \pm 0.12$	$20.85 \pm 0.09$	1.2-2.25	2

### Teleutostage

Teleutosori on all host plants occur on leaves, petioles or stems, even on pods, although there are some differences of appearance among forms on different plants.

The teleutosori on *Vicia Faba*, *V. hirsuta*, *V. sativa*, *V. tetrasperma* and *Pisum sativum* are hypophyllous as well as epiphyllous, but they are most abundantly produced on petioles and stems being rather rare on leaves. Those on *Lathyrus maritimus*, *L. palustris* var. *lineaeifolius*, *L. Davidii*, *Vicia amoena* var. *sachalinensis*, *V. Cracca* var. *japonica* mostly occur on the under surface of leaves, and those on *Vicia nipponica* var. *capitata* and *V. unijuga* are usually on both surfaces of leaves, rarely on petioles or stems.

In these fungi, the characters of the sori are nearly alike, macroscopically. The sori are compact, minute and round, elliptical to oblong in face view, attaining a length of 25 mm. or more on stems or

petioles. They are at first covered by the epidermis, soon naked, usually surrounded by the ruptured epidermis, chocolate brown to blackish brown in colour.

The teleutospores on these different plants also closely resemble each other in the general characters of their shape, colour and epispore. The spores are subglobose, ovate, ellipsoidal to obovate in shape. Their apices are bluntly acuminate or as frequently rounded, sometimes truncate, while the base is usually attenuate. Their

TABLE 8  
Biometric data for length of teleutospores of *Uromyces*  
*Fabae* and its related species (in  $\mu$ )

Material no.	Host plants	Range	Mode	Mean	Standard deviation
V-3h	<i>Vicia Faba</i>	27-42	33	34.50 $\pm$ 0.07	1.09 $\pm$ 0.05
V-3e	" "	27-42	33	34.38 $\pm$ 0.10	1.52 $\pm$ 0.07
V-3c	" "	27-42	33	34.16 $\pm$ 0.08	1.68 $\pm$ 0.06
V-3f	" "	27-42	33	34.14 $\pm$ 0.11	1.70 $\pm$ 0.08
V-3a	" "	27-42	33	34.08 $\pm$ 0.02	1.70 $\pm$ 0.06
V-3b	" "	27-42	33	33.53 $\pm$ 0.08	2.19 $\pm$ 0.05
V-3d	" "	27-42	33	33.99 $\pm$ 0.10	2.11 $\pm$ 0.07
P-1a	<i>Pisum sativum</i>	27-42	33	34.50 $\pm$ 0.07	1.09 $\pm$ 0.05
P-1b	" "	27-42	33	33.96 $\pm$ 0.17	2.53 $\pm$ 0.12
V-1a	<i>Vicia amoena</i> v. <i>sachalinensis</i>	27-42	33	33.90 $\pm$ 0.19	2.76 $\pm$ 0.13
V-5a	<i>V. japonica</i>	27-39	33	33.30 $\pm$ 0.19	2.62 $\pm$ 0.13
L-2a	<i>Lathyrus maritimus</i>	27-42	33	33.12 $\pm$ 0.09	1.89 $\pm$ 0.06
L-2d	" "	27-42	33	32.91 $\pm$ 0.19	2.79 $\pm$ 0.13
L-3a	<i>Lathyrus palustris</i> v. <i>lineaeifolius</i>	27-42	33	32.24 $\pm$ 0.18	2.74 $\pm$ 0.13
L-1a	<i>L. Davidii</i>	27-42	33	32.82 $\pm$ 0.19	2.78 $\pm$ 0.13
P-1c	<i>Pisum sativum</i>	27-39	33	32.10 $\pm$ 0.10	1.51 $\pm$ 0.07
P-1d	" "	24-39	33	31.74 $\pm$ 0.08	1.71 $\pm$ 0.06
V-9b	<i>Vicia unijuga</i>	27-39	33	32.76 $\pm$ 0.18	2.66 $\pm$ 0.13
V-9c	" "	24-42	33	31.32 $\pm$ 0.04	0.65 $\pm$ 0.03
V-2b	<i>Vicia Cracca</i> v. <i>japonica</i>	27-39	33	32.16 $\pm$ 0.14	2.14 $\pm$ 0.10
V-2a	" "	24-39	30	31.44 $\pm$ 0.10	1.48 $\pm$ 0.07
V-2c	" "	24-36	30	30.30 $\pm$ 0.15	2.23 $\pm$ 0.11
V-6a	<i>Vicia nipponica</i> v. <i>capitata</i>	24-36	30	29.61 $\pm$ 0.17	2.49 $\pm$ 0.12
V-6d	" "	27-36	30	29.79 $\pm$ 0.12	1.83 $\pm$ 0.09
V-4b	<i>Vicia hirsuta</i>	24-36	30	29.43 $\pm$ 0.19	2.81 $\pm$ 0.13
V-4a	" "	24-36	30	29.05 $\pm$ 0.10	2.07 $\pm$ 0.07
V-7a	<i>Vicia sativa</i>	24-36	30	29.43 $\pm$ 0.13	2.68 $\pm$ 0.09
V-7b	" "	24-33	30	28.92 $\pm$ 0.09	1.31 $\pm$ 0.06
V-8a	<i>Vicia tetrasperma</i>	24-36	30	29.28 $\pm$ 0.14	2.03 $\pm$ 0.10

episore is smooth and brown in colour, and is much thickened ( $4.5-12\mu$ ) and darker at the apex. Occasionally, a germ pore is visible at the thickened apex of the spore. Their pedicels are persistent and longer, up to  $108\mu$  in length, pale brown to yellow in colour. But, some differences in the size of the spores, in the length of their pedicels and in the thickness at the apex may be found among the fungi on different plants. The results of biometric studies on the teleutospores on different hosts are given in Tables 8 to 11.

TABLE 9  
Biometric data for width of teleutospores of *Uromyces*  
*Fabae* and its related species (in  $\mu$ )

Material no.	Host plants	Range	Mode	Mean	Standard deviation
V-3h	<i>Vicia Faba</i>	18-27	24	$23.10 \pm 0.10$	$1.51 \pm 0.07$
V-3e	" "	15-27	24	$23.53 \pm 0.13$	$1.88 \pm 0.09$
V-3c	" "	15-27	24	$23.54 \pm 0.07$	$1.44 \pm 0.05$
V-3f	" "	18-30	24	$24.12 \pm 0.17$	$2.46 \pm 0.12$
V-3a	" "	15-27	24	$22.53 \pm 0.01$	$0.26 \pm 0.01$
V-3b	" "	13-27	24	$22.99 \pm 0.03$	$1.07 \pm 0.02$
V-3d	" "	18-27	24	$23.55 \pm 0.08$	$1.72 \pm 0.06$
P-1a	<i>Pisum sativum</i>	18-27	24	$23.46 \pm 0.08$	$1.61 \pm 0.05$
P-1b	" "	18-30	24	$23.45 \pm 0.14$	$2.15 \pm 0.10$
V-1a	<i>Vicia amoena</i> v. <i>sachalinensis</i>	18-27	21	$21.81 \pm 0.12$	$1.73 \pm 0.08$
V-5a	<i>V. japonica</i>	18-27	21	$22.14 \pm 0.06$	$0.82 \pm 0.04$
L-2a	<i>Lathyrus maritimus</i>	18-27	24	$22.77 \pm 0.06$	$0.87 \pm 0.34$
L-2d	" "	21-27	24	$23.58 \pm 0.12$	$1.77 \pm 0.08$
L-3a	<i>Lathyrus palustris</i> v. <i>lineaeifolius</i>	18-30	24	$23.61 \pm 0.13$	$1.90 \pm 0.09$
L-1a	<i>L. Davidii</i>	18-30	24	$23.22 \pm 0.16$	$2.39 \pm 0.11$
P-1c	<i>Pisum sativum</i>	15-24	21	$20.21 \pm 0.06$	$1.19 \pm 0.04$
P-1b	" "	18-27	24	$22.65 \pm 0.02$	$0.36 \pm 0.02$
V-9b	<i>Vicia unijuga</i>	18-27	21	$21.90 \pm 0.11$	$1.59 \pm 0.08$
V-9c	" "	18-30	24	$22.65 \pm 0.04$	$0.63 \pm 0.03$
V-2b	<i>Vicia Cracca</i> v. <i>japonica</i>	18-24	21	$20.88 \pm 0.18$	$2.64 \pm 0.13$
V-2a	" "	18-30	21	$22.05 \pm 0.08$	$1.24 \pm 0.06$
V-2c	" "	18-27	21	$21.84 \pm 0.09$	$1.37 \pm 0.07$
V-6a	<i>Vicia nipponica</i> v. <i>capitata</i>	18-27	21	$21.93 \pm 0.09$	$1.23 \pm 0.06$
V-6d	" "	21-27	24	$22.97 \pm 0.07$	$1.02 \pm 0.05$
V-4b	<i>Vicia hirsuta</i>	15-24	21	$19.38 \pm 0.02$	$0.34 \pm 0.02$
V-4a	" "	15-24	21	$19.52 \pm 0.01$	$0.27 \pm 0.01$
V-7a	<i>Vicia sativa</i>	15-24	21	$19.53 \pm 0.01$	$0.16 \pm 0.01$
V-7b	" "	15-24	21	$19.56 \pm 0.02$	$0.25 \pm 0.01$
V-8a	<i>Vicia tetrasperma</i>	15-24	21	$19.68 \pm 0.02$	$0.35 \pm 0.02$

TABLE 10  
Length of pedicels and wall-thickness at apex in teleutospores  
of *Uromyces Fabae* and its related species (in  $\mu$ )

Material no.	Host plants	Length of pedicels	Wall-thickness at apex
V-3h	<i>Vicia Faba</i>	—102	4.5—10.5
V-3e	" "	— 96	4.5—10.5
V-3c	" "	— 90	6— 9
V-3f	" "	— 96	4.5—10.5
V-3a	" "	— 93	4.5—12
V-3b	" "	—108	4.5—12
V-3d	" "	—102	4.5— 9
P-1a	<i>Pisum sativum</i>	— 96	4.5—10.5
P-1b	" "	— 99	6—10.5
V-1a	<i>Vicia amoena</i> v. <i>sachalinensis</i>	— 90	4.5—10.5
V-5a	<i>V. japonica</i>	— 93	4.5—12
L-2a	<i>Lathyrus maritimus</i>	— 81	4.5—10.5
L-2d	" "	— 87	6—10.5
L-3a	<i>Lathyrus palustris</i> v. <i>lineaefolius</i>	— 90	6—10.5
L-1a	<i>L. Davidii</i>	—105	6—12
P-1c	<i>Pisum sativum</i>	— 99	4.5— 9
P-1d	" "	— 90	6—10.5
V-9b	<i>Vicia unijuga</i>	— 75	6—10.5
V-9c	" "	— 81	4.5—12
V-2b	<i>Vicia Cracca</i> v. <i>japonica</i>	— 87	6—12
V-2a	" "	— 90	4.5—10.5
V-2c	" "	— 93	4.5—12
V-6a	<i>Vicia nipponica</i> v. <i>capitata</i>	— 81	4.5—12
V-6d	" "	— 87	6—12
V-4b	<i>Vicia hirsuta</i>	— 57	4.5— 7.5
V-4a	" "	— 63	4.5— 9
V-7a	<i>Vicia sativa</i>	— 57	4.5— 9
V-7b	" "	— 66	4.5— 7.5
V-8a	<i>Vicia tetrasperma</i>	— 60	4.5— 9

The experimental data shown in Tables 8, 9 and 10 are summarized in the following table.



TABLE 11  
Summary of measurement of teleutospores of *Uromyces*  
*Fabae* and its related species (in  $\mu$ )

Host plants	Material no.	Length	Width	Length of pedicels	Wall-thickness at apex
<i>Vicia Faba</i>	V-3h	$34.50 \pm 0.07$	$23.10 \pm 0.10$	-102	4.5-10.5
	V-3e	$34.38 \pm 0.10$	$23.53 \pm 0.13$	-93	4.5-10.5
	V-3c	$34.16 \pm 0.08$	$23.54 \pm 0.07$	-90	6-9
	V-3f	$34.14 \pm 0.11$	$24.12 \pm 0.17$	-96	4.5-10.5
	V-3a	$34.08 \pm 0.02$	$22.53 \pm 0.01$	-93	4.5-12
	V-3b	$33.53 \pm 0.08$	$22.99 \pm 0.03$	-108	4.5-12
	V-3d	$33.99 \pm 0.10$	$23.55 \pm 0.08$	-102	4.5-9
<i>Pisum sativum</i>	P-1a	$34.50 \pm 0.07$	$23.46 \pm 0.08$	-96	4.5-10.5
	P-1b	$33.96 \pm 0.17$	$23.45 \pm 0.14$	-99	6-10.5
<i>Vicia amoena</i> v. <i>sachalinensis</i>	V-1a	$33.90 \pm 0.19$	$21.81 \pm 0.12$	-90	4.5-10.5
<i>V. japonica</i>	V-5a	$33.30 \pm 0.19$	$22.14 \pm 0.06$	-93	4.5-12
<i>Lathyrus maritimus</i>	L-2a	$33.12 \pm 0.09$	$22.77 \pm 0.06$	-81	4.5-10.5
	L-2d	$32.91 \pm 0.19$	$23.58 \pm 0.12$	-87	6-10.5
<i>L. palustris</i> v. <i>lineaeifolius</i>	L-3a	$32.24 \pm 0.18$	$23.61 \pm 0.13$	-90	6-10.5
<i>L. Davidii</i>	L-1a	$32.82 \pm 0.19$	$23.22 \pm 0.16$	-105	6-12
<i>Pisum sativum</i>	P-1c	$32.10 \pm 0.10$	$20.21 \pm 0.06$	-99	4.5-9
	P-1d	$31.74 \pm 0.08$	$22.65 \pm 0.02$	-90	6-10.5
<i>Vicia unijuga</i>	V-9b	$32.76 \pm 0.18$	$21.90 \pm 0.11$	-75	6-10.5
	V-9c	$31.32 \pm 0.04$	$22.65 \pm 0.04$	-81	4.5-12
<i>V. Cracca</i> v. <i>japonica</i>	V-2b	$32.16 \pm 0.14$	$20.88 \pm 0.18$	-87	6-12
	V-2a	$31.44 \pm 0.10$	$22.05 \pm 0.08$	-90	4.5-10.5
	V-2c	$30.30 \pm 0.15$	$21.84 \pm 0.09$	-93	4.5-12
<i>V. nipponica</i> v. <i>capitata</i>	V-6a	$29.61 \pm 0.17$	$21.93 \pm 0.09$	-81	4.5-12
	V-6d	$29.79 \pm 0.12$	$22.97 \pm 0.07$	-87	6-12
<i>V. hirsuta</i>	V-4b	$29.43 \pm 0.19$	$19.38 \pm 0.02$	-57	4.5-7.5
	V-4a	$29.05 \pm 0.10$	$19.52 \pm 0.01$	-63	4.5-9
<i>V. sativa</i>	V-7a	$29.43 \pm 0.13$	$19.53 \pm 0.01$	-57	4.5-9
	V-7b	$28.92 \pm 0.09$	$19.56 \pm 0.02$	-66	4.5-7.5
<i>V. tetrasperma</i>	V-8a	$29.28 \pm 0.14$	$19.68 \pm 0.02$	-60	4.5-9

From the above table, the writer detected at first that the teleuto-spores on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* are smaller than others. The spores on these three plants measure  $28.92 \pm 0.09 - 29.43 \pm 0.19 \mu$  in length and  $19.38 \pm 0.02 - 19.68 \pm 0.02 \mu$  in width. (Pl. XVII, fig. 8). The spores on the other ten plants out of the above three species of *Vicia*, closely resemble each other in size, although the spores from a certain plant are smaller on one side, and those from a certain other one larger than others on the other side. For example, the spores on *Vicia Faba* (Pl. XVII, fig. 5) and *Pisum sativum* (P-1a, b) are somewhat larger, and those on *Vicia nipponica* var. *capitata* (Pl. XVII, fig. 7), *V. Cracca* var. *japonica* and *Pisum sativum* (P-1c, d) are smaller than others. Many transitional forms of spores in respect to size also exist on different hosts.

The wall-thickness at the apex in the spores on different plants is nearly always the same, measuring  $4.5-12 \mu$ . The pedicels of the spores are variable in length, but those on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* are constantly more or less shorter than those on others.

### Conclusions and taxonomic considerations

From the results of the foregoing experiments, the fungi on the thirteen different plants may be divided morphologically into ten forms as follows:—1) On *Vicia Faba* (V-3a-h) and *Pisum sativum* (P-1a, b), 2) On *Pisum sativum* (P-1c, d) and *Vicia Cracca* var. *japonica* (V-2a-c), 3) On *Vicia amoena* var. *sachalinensis* (V-1a), 4) On *Vicia japonica* (V-5a, b), 5) On *Lathyrus Davidii* (L-1a, b), 6) In *Lathyrus palustris* var. *lineaefolius* (L-3a, b), 7) On *Lathyrus maritimus* (L-2a-d), 8) On *Vicia nipponica* var. *capitata* (V-6a-d), 9) On *Vicia unijuga* (V-9a-c) and 10) On *Vicia hirsuta* (V-4a-c), *V. sativa* (V-7a, b) and *V. tetrasperma* (V-8a).

As indicated above, no difference of morphological characters has ever been found among the fungi on *Vicia Faba* and those on *Pisum sativum* (P-1a, b), those on *Vicia Cracca* var. *japonica* and *Pisum sativum* (P-1c, d), nor among those on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*.

The writer attempted to compare these forms on different plants with foreign specimens distributed as *Uromyces Fabae*, *U. Orobi* or *U. Ervi*. The form on *Vicia Faba* and *Pisum sativum* (P-1a, b) is identical with *Uromyces Fabae* on *Vicia Faba* from Europe, North

America and others in respect to morphological characters of all spore forms. The form of *Pisum sativum* (P-1c, d) and *Vicia Cracca* var. *japonica* very closely resembles the European form of *Uromyces Fabae* on *Vicia Cracca*. The form on *Lathyrus Davidii*, *Vicia nipponica* var. *capitata* and *V. unijuga* resembles the European forms of *Uromyces Fabae* on *Lathyrus niger* and *L. vernus* and *Uromyces Orobi* on *Lathyrus montanus*, though some differences exist among them. Especially, a form on *Lathyrus Davidii* is closely similar to the European species, *Uromyces Orobi*. The fungi on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* agree with European specimens of *Uromyces Ervi* on *Vicia hirsuta* in important points.

In the following paragraphs, the writer will set down his taxonomic considerations regarding these fungi. It is his view that the characters of germ pores and wall-thickness of the uredospores as well as the size of uredo- and teleutospores are important for the classification of this group.

1) *The germ pores of uredospores*—Germ pores characterize the uredospores of the majority of the rust fungi. As far as the writer knows, Fischer is the first who clearly reported on germ pores of uredospores of *Uromyces Fabae* and its related species. In his monograph, he (11) stated that the germ pores of *Uromyces Fabae* and *U. Orobi* are 3 or 4, while those of *Uromyces Ervi* are 2 (rarely 3) on the equatorial portion. Since then, ARTHUR (1), the SYDOWS (32), GROVE (13), ITÔ (24) and others have reported these characters in their descriptions of these species. As a character of marked taxonomic value, the most distinctive feature of *Uromyces Ervi*, differing from *Uromyces Fabae* and *U. Orobi* is the number and position of germ pores of the uredospores.

As shown in the foregoing pages, the uredospores on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* show 2 equatorial pores, while those on the other plants are 3 to 5 in number scattered over the whole surface of the spores. In the characters of germ pores, therefore, the uredospores on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* agree with those of *Uromyces Ervi*, while the spores on the other plants agree with those of *Uromyces Fabae* or *U. Orobi*.

2) *The wall-thickness of uredospores*—In 1904, JORDI (25) clearly described the wall-thickness of uredospores of *Uromyces Fabae* and *U. Orobi*. He stated:—"Die Uredosporen der Form auf *Lathyrus montanus* sind konstant dickwandig; es beträgt die Membrandicke

3–4  $\mu$ . Zum Unterschiede mit der Form auf *Lath. montanus* sind die Uredosporen der übrigen biologischen Arten dünnwandig (1.2–2.0  $\mu$ ) und nur ausnahmsweise wurden Uredosporen mit einer Membrandicke von 2–2.5  $\mu$  beobachtet." Since that time, the SYDOWS (32), GROVE (13), FISCHER (11) and others have treated the fungus on *Lathyrus montanus* as a distinct species, *Uromyces Orobi*, distinguished from *Uromyces Fabae* on account of having the thick-walled uredospores.

In 1913, KLEBAHN (27) reported on *Uromyces Orobi* as follows: "An dem mir vorliegenden Material sind die Uredosporenmembranen nicht dicker als an den verschiedenen Exsikkaten von *U. fabae*, ca. 2–2.5  $\mu$ . Die Dicke 4  $\mu$  erreichen nur einzelne Sporen mit farbloser, aufgequollen erscheinender Membran. Ich möchte *U. orobi* daher für eine wesentlich nur biologisch verschiedene Form halten, die mit den Formen von *U. fabae* auf gleiche Stufe zu stellen ist."

DIETEL (8) recorded the occurrence of *Uromyces Orobi* on *Lathyrus Davidii* and *L. maritimus* from Japan, remarking the wall of their uredospores as very thick. In 1922, ITÔ (24) reported that the wall of the spores on *Lathyrus maritimus* from our country is always thinner than that of *Uromyces Orobi*, and he treated this fungus as *Uromyces Fabae*. But, he did not discuss the fungus on *Lathyrus Davidii*, because he had never been able to examine any specimen on this plant. Moreover, he identified *Uromyces* on *Vicia unijuga* with *Uromyces Orobi*, with the following remarks:—"The whole character of this species coincides with *Uromyces Fabae*, except the epispore of uredospores of the former being thicker than that of the latter species (namely 2–3  $\mu$  against 1.5–2.5  $\mu$ )."

As shown in the results of the writer's examination, the epispore of uredospores on *Lathyrus Davidii* is remarkably thick (2–3.5  $\mu$ ), as already pointed out by DIETEL, and that of uredospores on *Vicia nipponica* var. *capitata* and *V. unijuga* is moderately thick (1.5–3  $\mu$ ), while that on *Vicia Faba*, *V. Cracca* var. *japonica*, *V. japonica*, *Lathyrus maritimus*, *L. palustris* var. *lineaefolius* and *Pisum sativum* is thin (1.2–2.25  $\mu$ ). It may be seen that uredospores on *Vicia nipponica* var. *capitata* and *V. unijuga* are transitional forms between thick- and thin-walled forms. Sometimes, thicker walled uredospores (1.8–2.5  $\mu$  thick) were found in the sori on *Vicia Cracca* var. *japonica* and *Lathyrus maritimus*.

The writer examined a number of European specimens of *Uromyces Orobi* on *Lathyrus montanus* and he clearly found that



the wall of uredospores of this species is thick ( $2-3.5\mu$ ), as already stated by European mycologists. He also found that a form on *Lathyrus Davidii* is nearly identical with European species in the wall-thickness of uredospores as well as in other important characters. A tendency seems to exist for uredospores of forms on *Vicia nipponica* var. *capitata* and *V. unijuga*, which have been treated provisionally by ITÔ and the writer as *Uromyces Orobi*, to be more or less thinner than those of European species on *Lathyrus montanus* and also than those on a Japanese form on *Lathyrus Davidii*.

3) *The size of uredospores*—The uredospores on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* are smaller than those on the others. A comparison of the uredospores of the fungus on these three plants with those of *Uromyces Ervi* based upon European specimens shows that this fungus in question agrees with the latter in the size of its uredospores.

Excepting the above three the uredospores on the other various plants range  $25.62\pm0.11-28.50\pm0.01\mu$  in length and  $21.60\pm0.09-24.02\pm0.09\mu$  in width. Among them, the spores on *Vicia nipponica* var. *capitata*, *V. unijuga* and *Lathyrus Davidii* are more or less larger and those on *Pisum sativum* (P-1c, d) and *Vicia Cracca* var. *japonica* are somewhat smaller than those on other plants.

By careful examination of American and European specimens of *Uromyces Fabae* on various species of *Vicia* and *Lathyrus*, determined by some authorities, such as, DIETEL, FISCHER, JØRSTAD, ARTHUR, CONSTANTINEANU, JACKSON, the SYDOWS and others, the writer has found that those on any one certain host are always smaller or larger than those on others.

4) *The size of teleutospores*—As shown in the results of the experiments, the teleutospores on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* are distinctly smaller than on others. But, there seems to be a tendency for them to be more or less larger than those of European specimens of *Uromyces Ervi*, namely  $28.92\pm0.09-29.43\pm0.19\mu$  against  $25.8-27.05\mu$  in length and  $19.38\pm0.02-19.68\pm0.02\mu$  against  $18.86-19.17\mu$  in width. (Herb. CONSTANTINEANU, nos. 2835, 3017).

The teleutospores on other plants are variable in size, but, they are generally larger than those on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*. The spores on *Vicia Faba* and *Pisum sativum* (P-1a, b) are larger and those on *Vicia Cracca* var. *japonica*, *V. japonica*,

*V. nipponica* var. *capitata* and *Pisum sativum* (P-1c, d) are smaller than others. Between them, many transitional forms also exist on different hosts. The writer measured the teleutospores on a number of American and European specimens of *Uromyces Fabae*, distributed by some authorities, and found that the teleutospores agree in general with Japanese ones, although these on different hosts are variable in size as is the case in the Japanese fungi.

TABLE 12

Measurement of teleutospores from foreign specimens of *Uromyces Fabae*  
(50 spores measured from each material)

Host plants	Sources of specimens	Length (in $\mu$ )	Width (in $\mu$ )	Note
<i>Vicia Faba</i>	{ I.C. CONSTANTINEANU, Herb. { Myc. Romaniae no. 1634	34.90	23.54	{ Determined by { CONSTANTINEANU
" "	{ Fungi of China, Herb. Univ. { Nanking, no. 584	33.92	24.14	{ Determined by { H. SYDOW
" "	Waldenburg, Sa., Germany	34.12	23.87	{ Determined by { P. DIETEL
<i>Vicia sepium</i>	{ I.C. CONSTANTINEANU, Herb. { Myc. Romaniae no. 1708	31.28	21.45	{ Determined by { CONSTANTINEANU
" "	Egge near Steinkjer, Norway	30.23	21.15	{ Determined by { I. JØRSTAD
<i>Vicia segetialis</i>	{ I.C. CONSTANTINEANU, Herb. { Myc. Romaniae no. 3031	31.62	21.12	{ Determined by { CONSTANTINEANU
<i>V. Cracca</i>	Skedsmo, Norway	31.94	20.43	{ Determined by { I. JØRSTAD
<i>Lathyrus niger</i>	Brevik, Norway	32.26	21.99	{ Determined by { I. JØRSTAD
<i>L. vernus</i>	SYDOW, Myc. Germ. no. 1835	32.37	23.22	
" "	{ Skaugumsåsen in Asker, { Norway	30.78	21.96	{ Determined by { I. JØRSTAD

From his taxonomic considerations above mentioned, the writer concluded as follows:—

1) The fungus on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* is treated as *Uromyces Ervi* (WALLR.) WEST., although the teleutospores of the Japanese specimens are somewhat larger than those of the typical European form.

2) All forms of seven Japanese plants, such as, *Vicia amoena* var. *sachalinensis*, *V. Cracca* var. *japonica*, *V. Faba*, *V. japonica*, *Lathyrus maritimus*, *L. palustris* var. *lineaefolius* and *Pisum sativum* are treated as one and the same collective species, *Uromyces Fabae* (PERS.) DE BARY.

3) The forms on *Lathyrus Davidii*, *Vicia nipponica* var. *capitata* and *V. unijuga* are identified with *Uromyces Orobi* (PERS.) LÉV.

Moreover, the writer considers that the form on *Vicia nipponica* var. *capitata* and *V. unijuga* possibly holds a sort of intermediate position between *Uromyces Orobi* on its type host, *Lathyrus montanus*, and a form of *Uromyces Fabae* on *Lathyrus vernus* and *L. niger*.

### Biology of *Uromyces Fabae*, *U. Orobi* and *U. Ervi*

It is to be expected that polymorphous species like *Uromyces Fabae*, *U. Orobi* or *U. Ervi*, as demonstrated in the foregoing chapter, are physiologically highly specialized.

The biology of these species has been already investigated by PLOWRIGHT (30), JORDI (25), BUBÁK (2), FISCHER (10) and DIETEL (5).

PLOWRIGHT (30), in 1889, probably was the first to suggest a possibility of specialization within *Uromyces Fabae*. He made two series of inoculation experiments with teleutospores of a form of *Uromyces Fabae* from *Vicia Faba* on *Vicia Cracca*, *V. Faba*, *V. hirsuta* (*Ervum hirsutum*), *V. sativa*, *Pisum sativum* and *Lathyrus pratensis*, and secured positive results on *Vicia Faba* and *Pisum sativum*, while on the remaining plants inoculations were unsuccessful.

JORDI (25) has distinguished under *Uromyces Fabae* three "biological" races: 1) on *Vicia Faba* and *Pisum sativum*, 2) on *Lathyrus vernus* and probably also on *Pisum sativum*, 3) on *Vicia Cracca*, *Pisum sativum* and probably also on *Vicia hirsuta*. FISCHER (10) reported that a form of the same species from *Vicia Cracca* was transferred on to *Pisum sativum*. BUBÁK (2) stated that aecidiospores and teleutospores of the same species from *Lathyrus vernus* failed to infect on *Vicia Faba*.

JORDI (25) made attempts to inoculate *Uromyces Orobi* on *Lathyrus montanus* upon *Lathyrus vernus*, *L. pratensis*, *L. lutens*, *L. niger*, *Vicia sativa*, *V. Faba*, *V. hirsuta*, *V. angustifolia* and *Pisum sativum*, but in every case without success.

PLOWRIGHT (30) also stated that inoculations with *Uromyces Ervi* on *Vicia hirsuta* were unsuccessful on *Vicia Cracca*, *V. sativa*, *V. Faba*, *Pisum sativum* and *Lathyrus pratensis*. Then, JORDI (25) also got negative results on *Vicia Faba*, *V. sativa*, *Pisum sativum*, *Lathyrus pratensis* and *Ervum Ervum* in inoculations with *Uromyces Ervi* from *Vicia hirsuta*.

DIETEL(5) was apparently the first to report that *Uromyces Ervi* has repeating aecidia. He obtained the aecidial stage, but not the uredostage on *Vicia hirsuta* by inoculating with the aecidiospores from the same host plant. JORDI also confirmed this fact in the same fungus.

### **Inoculation experiments with *Uromyces Fabae*, *U. Orobi* and *U. Ervi***

Inoculation experiments were undertaken in order to determine the parasitism of various forms of *Uromyces Fabae*, *U. Orobi* and *U. Ervi*.

The spores used as inoculum were taken from well-developed and fresh sori. The inoculated plants were raised in small pots, 12–16 cm. in diameter, about one to four plants to a pot, and inoculated in the seedling stage. The method used was to make a spore suspension and to spray it on leaves of the potted plant by means of an atomizer until the leaf surfaces were covered with very fine drops. The inoculated plant was covered with a bell jar or put into an inoculation chamber as soon as possible after sowing of the spores. After two or three days had passed, the treated pot was transferred from the bell jar or the inoculation chamber and watered well every day.

### ***Uromyces Fabae***

#### **1. Inoculations with the uredospores on *Vicia Faba***

a. *Experiments in 1930.* The uredospores of the present species on *Vicia Faba* were obtained from one of our experimental plots in October 1929, and were transferred to the same host plant by artificial inoculations in the glass house. These constituted the inoculating materials<sup>(1)</sup>. Inoculations were made with the uredospores cultured in the glass house on the following ten species, viz. *Vicia Faba*, *V. hirsuta*, *V. sativa*, *V. tetrasperma*, *Lathyrus maritimus*, *Pisum sativum*, *Phaseolus radiatus* L. var. *aurea* PRAIN, *Lotus corniculatus* L. var. *japonicus* RGL., *Glycine Soja* BENTH. and *Vigna sinensis* ENDL. The results of the experiments are given in the following table.

---

(1) The same materials were used for morphological studies. (Material no. V-3a, b).



TABLE 13  
Results of inoculation experiments with uredospores  
of *Uromyces Fabae* on *Vicia Faba*-1

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
1	<i>Vicia Faba</i> <sup>(1)</sup>	April 15, 1930	April 23
2	<i>V. hirsuta</i>	April 15, 1930	—
3	<i>Lotus corniculatus</i> v. <i>japonicus</i>	April 15, 1930	—
4	<i>Pisum sativum</i> <sup>(2)</sup>	April 22, 1930	May 2
5	<i>Vicia Faba</i>	April 22, 1930	May 1
6	<i>V. sativa</i>	April 22, 1930	—
7	<i>V. tetrasperma</i>	April 22, 1930	—
8	<i>V. Faba</i>	May 13, 1930	May 22
9	<i>V. hirsuta</i>	May 13, 1930	—
10	<i>V. sativa</i>	May 13, 1930	—
11	<i>Glycine Soja</i>	May 15, 1930	—
12	<i>Phaseolus radiatus</i> var. <i>aurea</i>	May 15, 1930	—
13	<i>Vicia Faba</i>	May 15, 1930	May 24
14	<i>Vigna sinensis</i>	May 15, 1930	—

As shown in this table, infection followed with a marked development of uredosori on *Pisum sativum* and the control plant, *Vicia Faba*, while on the remaining plants no sign of uredosori appeared.

b. *Experiments in 1931.* Two series of experiments were carried out in 1931. In the first series, the experiments (nos. 15-27) were made with the uredospores on *Vicia Faba* which were collected by M. YOSHIDA at Okayama, province of Bizen on May 15, 1931, and had been cultured carefully on the same plant. In the second series (Experiment nos. 28-39), the uredospores which were gotten from Sapporo on September 12, 1931 and had then been cultured in our laboratory were used as inoculum. The uredospores were inoculated on leaves of *Astragalus sinicus* L., *Lathyrus Davidii*, *L. maritimus*, *L. odoratus* L., *Pisum sativum*, *Vicia atropurpurea* DESF., *V. Cracca* var. *japonica*, *V. Faba*, *V. hirsuta*, *V. monantha* RETZ., *V. nipponica*

(1) The variety of broad bean used in the inoculation experiments is "Issun-soramame" or "Otafuku."

(2) The variety of pea used in the inoculation experiments is "American Wonder" or "Pioneer."

var. *capitata*, *V. pannonica* CRANTZ., *V. sativa*, *V. unijuga* and *V. villosa* ROTH. The results of the inoculation experiments are presented in the following table.

TABLE 14

Results of inoculation experiments with uredospores  
of *Uromyces Fabae* on *Vicia Faba*-2

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
15	<i>Astragalus sinicus</i>	May 15, 1931	—
16	<i>Vicia Faba</i>	May 15, 1931	May 23
17	<i>V. unijuga</i>	May 15, 1931	—
18	<i>Lathyrus Davidii</i>	May 31, 1931	—
19	<i>L. maritimus</i>	May 31, 1931	—
20	<i>L. odoratus</i>	May 31, 1931	—
21	<i>Pisum sativum</i>	May 31, 1931	June 7
22	<i>Vicia Cracca</i> var. <i>japonica</i>	May 31, 1931	—
23	<i>V. Faba</i>	May 31, 1931	June 8
24	<i>V. hirsuta</i>	May 31, 1931	—
25	<i>V. nipponica</i> var. <i>capitata</i>	May 31, 1931	—
26	<i>V. sativa</i>	May 31, 1931	—
27	<i>V. tetrasperma</i>	May 31, 1931	—
28	<i>Pisum sativum</i>	Oct. 2, 1931	Oct. 11
29	<i>Vicia atropurpurea</i>	Oct. 2, 1931	—
30	<i>V. Cracca</i> var. <i>japonica</i>	Oct. 2, 1931	—
31	<i>V. Faba</i>	Oct. 2, 1931	Oct. 9
32	<i>V. hirsuta</i>	Oct. 2, 1931	—
33	<i>V. monantha</i>	Oct. 2, 1931	—
34	<i>V. nipponica</i> var. <i>capitata</i>	Oct. 2, 1931	—
35	<i>V. pannonica</i>	Oct. 2, 1931	—
36	<i>V. sativa</i>	Oct. 2, 1931	—
37	<i>V. tetrasperma</i>	Oct. 2, 1931	—
38	<i>V. unijuga</i>	Oct. 2, 1931	—
39	<i>V. villosa</i>	Oct. 2, 1931	—

The above table shows that positive results were obtained on *Pisum sativum* and *Vicia Faba*, while on the remaining plants inoculations were unsuccessful as in the case of the 1930 experiments.

2. Inoculations with the uredospores on *Pisum sativum*

The uredospores on leaves of *Pisum sativum* growing among a field of broad bean (*Vicia Faba*) which were severely affected by the uredo- and teleutostage of the present species, were collected by M. YOSHIDA at Omokage-mura near Tottori on May 28, 1930. (Material no. P-1b in the morphological studies) They were inoculated on leaves of *Lathyrus maritimus*, *Pisum sativum* and *Vicia Faba*. As seen in the following table, positive results were secured on the latter two plants, while on *Lathyrus maritimus* the inoculations were unsuccessful.

TABLE 15  
Results of inoculation experiments with uredospores of  
*Uromyces Fabae* on *Pisum sativum*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
40	<i>Lathyrus maritimus</i>	May 28, 1930	—
41	<i>Pisum sativum</i>	May 28, 1930	June 7
42	<i>Vicia Faba</i>	May 28, 1930	June 5

3. Inoculations with the aecidiospores on *Pisum sativum*

For the inoculating materials, numerous aecidia and uredosori on leaves of *Pisum sativum* were collected by the writer at Inabayama near Tottori on May 24, 1931. Inoculations with aecidiospores from the well-matured aecidia were made on *Lathyrus maritimus*, *Pisum sativum*, *Vicia Faba*, *V. hirsuta* and *V. tetrasperma*, but uredosori appeared only on the control plant, *Pisum sativum*, while on the remaining species the inoculations were unsuccessful as shown in the following table.

TABLE 16  
Results of inoculation experiments with aecidiospores of  
*Uromyces Fabae* on *Pisum sativum*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
43	<i>Lathyrus maritimus</i>	May 25, 1931	—
44	<i>Pisum sativum</i>	May 25, 1931	June 4
45	<i>Vicia Faba</i>	May 25, 1931	—
46	<i>V. hirsuta</i>	May 25, 1931	—
47	<i>V. tetrasperma</i>	May 25, 1931	—

Experiments with the uredospores on the same leaves of *Pisum sativum* were also made on the same plants with results the same as in the case of the experiments with the aecidiospores.

#### 4. Inoculations with the uredospores on *Lathyrus maritimus*

a. *Experiments in 1930.* In this series, inoculations with the uredospores on *Lathyrus maritimus* collected by M. YOSHIDA from Hamasaka near Tottori on May 14, 1930 (Material no. L-2b in the morphological studies) were made on *Lathyrus maritimus* and *Vicia Faba*. In the following table, the results of the experiments are given.

TABLE 17  
Results of inoculation experiments with uredospores of  
*Uromyces Fabae* on *Lathyrus maritimus*-1

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
48	<i>Lathyrus maritimus</i>	May 14, 1930	May 24
49	<i>Vicia Faba</i>	May 14, 1930	—

As seen from Table 17, uredosori appeared on *Lathyrus maritimus*, while no sign appeared on the inoculated leaves of *Vicia Faba*.

b. *Experiments in 1931.* In these experiments, uredospores on leaves of *Lathyrus maritimus* which had been collected by the writer at Hamasaka near Tottori on June 7, 1931 were used as inoculum. The inoculated plants were the following five species of *Vicia* and three of *Lathyrus*: *Vicia Cracca* var. *japonica*, *V. Faba*, *V. hirsuta*, *V. sativa*, *V. tetrasperma*, *Lathyrus Davidii*, *L. maritimus* and *L. odoratus*. The results of the experiments are given in the following table.

TABLE 18  
Results of inoculation experiments with uredospores of  
*Uromyces Fabae* on *Lathyrus maritimus*-2

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
50	<i>Lathyrus Davidii</i>	June 7, 1931	—
51	<i>L. maritimus</i>	June 7, 1931	June 19
52	<i>L. odoratus</i>	June 7, 1931	—
53	<i>Vicia Cracca</i> v. <i>japonica</i>	June 7, 1931	—
54	<i>V. Faba</i>	June 7, 1931	—
55	<i>V. hirsuta</i>	June 7, 1931	—
56	<i>V. sativa</i>	June 7, 1931	—
57	<i>V. tetrasperma</i>	June 7, 1931	—



As shown in the above table, it was not possible to transfer the form on *Lathyrus maritimus* to other plants, not even those belonging to the same genus.

### 5. Conclusions

Summary of the preceding data is given in the following table.

TABLE 19  
Summary of the results of the inoculation experiments  
with *Uromyces Fabae*

Materials inoculated	Experiment no.	Plants inoculated	Results	Notes
Uredo-spores on <i>Vicia Faba</i>	15	<i>Astragalus sinicus</i>	—	f. sp. <i>Viciae-Fabae</i>
	11	<i>Glycine Soja</i>	—	
	18	<i>Lathyrus Davidii</i>	+	
	19	<i>L. maritimus</i>	—	
	20	<i>L. odoratus</i>	—	
	3	<i>Lotus corniculatus</i> var. <i>japonicus</i>	—	
	12	<i>Phaseolus radiatus</i> var. <i>aurea</i>	—	
	4, 21, 28	<i>Pisum sativum</i>	+	
	29	<i>Vicia atropurpurea</i>	—	
	22, 30	<i>V. Cracca</i> var. <i>japonica</i>	—	
	1, 5, 8, 13, 16, 23, 31	<i>V. Faba</i>	+	
	2, 9, 24, 32	<i>V. hirsuta</i>	—	
	33	<i>V. monantha</i>	—	
	25, 34	<i>V. nipponica</i> var. <i>capitata</i>	—	
	35	<i>V. pannonica</i>	—	
	6, 10, 26, 36	<i>V. sativa</i>	—	
	7, 27, 37	<i>V. tetrasperma</i>	—	
Uredo-spores on <i>Pisum sativum</i>	17, 38	<i>V. unijuga</i>	—	
	39	<i>V. villosa</i>	—	
	14	<i>Vigna sinensis</i>	—	
Uredo-spores on <i>Pisum sativum</i>	40	<i>Lathyrus maritimus</i>	—	
	41	<i>Pisum sativum</i>	+	
	42	<i>Vicia Faba</i>	+	
Aecidio-spores on <i>Pisum sativum</i>	43	<i>Lathyrus maritimus</i>	—	f. sp. <i>Pisi-sativae</i>
	44	<i>Pisum sativum</i>	+	
	45	<i>Vicia Faba</i>	—	
	46	<i>V. hirsuta</i>	—	
	47	<i>V. tetrasperma</i>	—	

TABLE 19 (Continued)

Materials inoculated	Experiment no.	Plants inoculated	Results	Notes
Uredospores on <i>Lathyrus maritimus</i>	50	<i>Lathyrus Davidii</i>	—	f. sp. <i>Lathyri-maritimi</i>
	48, 51	<i>L. maritimus</i>	+	
	52	<i>L. odoratus</i>	—	
	53	<i>Vicia Cracca</i> var. <i>japonica</i>	—	
	49, 54	<i>V. Faba</i>	—	
	55	<i>V. hirsuta</i>	—	
	56	<i>V. sativa</i>	—	
	57	<i>V. tetrasperma</i>	—	

As is evident from the above table, in a collective species, *Uromyces Fabae* on different plants have been distinguished into the following three different specialized forms.

1) f. sp. *Viciae-Fabae*. Favorable hosts for this form are *Vicia Faba* and *Pisum sativum*. There was no sign of infection by inoculating with the uredospores of this form on *Astragalus sinicus*, *Glycine Soja*, *Lathyrus Davidii*, *L. maritimus*, *L. odoratus*, *Lotus corniculatus* var. *japonicus*, *Phaseolus radiatus* var. *aurea*, *Vicia atropurpurea*, *V. Cracca* var. *japonica*, *V. hirsuta*, *V. monantha*, *V. nipponica* var. *capitata*, *V. pannonica*, *V. sativa*, *V. tetrasperma*, *V. unijuga*, *V. villosa* and *Vigna sinensis*.

2) f. sp. *Pisi-sativae*. The host plant of this form is *Pisum sativum* only. This fact shows that this form is highly specialized. It was not transferable to *Lathyrus maritimus*, *Vicia Faba*, *V. hirsuta* and *V. tetrasperma*.

3) f. sp. *Lathyri-maritimi*. It has not been possible to transfer this form on *Lathyrus maritimus* to *Lathyrus Davidii*, *L. odoratus*, *Vicia Cracca* var. *japonica*, *V. Faba*, *V. hirsuta*, *V. sativa* and *V. tetrasperma*.

### *Uromyces Orobi*

#### 1. Inoculations with the aecidiospores on *Vicia nipponica* var. *capitata*

The aecidiospores on leaves and stems of *Vicia nipponica* var. *capitata* which had been collected by the writer at Inabayama near

Tottori on May 31, 1931 were used for the inoculating materials. The inoculated plants were *Vicia Faba*, *V. hirsuta*, *V. sativa*, *V. tetrasperma*, *V. nipponica* var. *capitata*, *V. unijuga* and *Pisum sativum*. The results are tabulated as follows:

TABLE 20  
Results of inoculation experiments with aecidiospores of  
*Uromyces Orobi* on *Vicia nipponica* var. *capitata*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
58	<i>Pisum sativum</i>	June 1, 1931	—
59	<i>Vicia Faba</i>	June 1, 1931	—
60	<i>V. hirsuta</i>	June 1, 1931	—
61	<i>V. nipponica</i> var. <i>capitata</i>	June 1, 1931	June 12
62	<i>V. sativa</i>	June 1, 1931	—
63	<i>V. tetrasperma</i>	June 1, 1931	—
64	<i>V. unijuga</i>	June 1, 1931	—

As seen from the preceding table, numerous uredosori appeared only on the control plant, *Vicia nipponica* var. *capitata*, while on the remaining plants the results were negative.

## 2. Inoculations with the uredospores on *Vicia nipponica* var. *capitata*

In this series, use was made of the uredospores on *Vicia nipponica* var. *capitata* obtained from the same source as in the immediately preceding experiments. The results are given in the following table.

TABLE 21  
Results of inoculation experiments with uredospores of  
*Uromyces Orobi* on *Vicia nipponica* var. *capitata*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
65	<i>Vicia Cracca</i> var. <i>japonica</i>	June 1, 1931	—
66	<i>V. Faba</i>	June 1, 1931	—
67	<i>V. hirsuta</i>	June 1, 1931	—
68	<i>V. nipponica</i> var. <i>capitata</i>	June 1, 1931	June 13
69	<i>V. sativa</i>	June 1, 1931	—

TABLE 21 (Continued)

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
70	<i>Vicia tetrasperma</i>	June 1, 1931	—
71	<i>V. unijuga</i>	June 1, 1931	—
72	<i>V. atropurpurea</i>	Sept. 27, 1931	—
73	<i>V. Cracca</i> var. <i>japonica</i>	Sept. 27, 1931	—
74	<i>V. hirsuta</i>	Sept. 27, 1931	—
75	<i>V. pannonica</i>	Sept. 27, 1931	—
76	<i>V. monantha</i>	Sept. 27, 1931	—
77	<i>V. nipponica</i> var. <i>capitata</i>	Sept. 27, 1931	Oct. 8
78	<i>V. sativa</i>	Sept. 27, 1931	—
79	<i>V. tetrasperma</i>	Sept. 27, 1931	—
80	<i>V. unijuga</i>	Sept. 27, 1931	—
81	<i>V. villosa</i>	Sept. 27, 1931	—

It is clearly shown in the above data, that amongst the eleven species of *Vicia* tried, uredosori appeared only on the control plant, *Vicia nipponica* var. *capitata*, and did not appear on the remaining species at all.

### 3. Inoculations with the uredospores on *Vicia unijuga*

In the present experiment, the uredospores on *Vicia unijuga* which were collected by the writer at Inabayama near Tottori on May 31, 1931, were inoculated on *Vicia Faba*, *V. hirsuta*, *V. nipponica* var. *capitata*, *V. unijuga* and *Pisum sativum*. The results of the experiments are tabulated as follows:

TABLE 22  
Results of inoculation experiments with uredospores of  
*Uromyces Orobi* on *Vicia unijuga*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
82	<i>Pisum sativum</i>	June 1, 1931	—
83	<i>Vicia Faba</i>	June 1, 1931	—
84	<i>V. hirsuta</i>	June 1, 1931	—
85	<i>V. nipponica</i> var. <i>capitata</i>	June 1, 1931	—
86	<i>V. unijuga</i>	June 1, 1931	June 11



These experiments indicate that the fungus on *Vicia unijuga* is clearly confined to the one host, as no infection took place on either *Vicia Faba*, *V. hirsuta*, *V. nipponica* var. *capitata* or *Pisum sativum*.

#### 4. Conclusions

From the data of these experiments, the writer distinguishes the morphological species, *Uromyces Orobi* into the following two specialized forms.

1) f. sp. *Viciae-nipponicae*. This specialized form is confined to *Vicia nipponica* var. *capitata*. It does not infect on *Pisum sativum*, *Vicia atropurpurea*, *V. Cracca* var. *japonica*, *V. Faba*, *V. hirsuta*, *V. monantha*, *V. pannonica*, *V. sativa*, *V. tetrasperma*, *V. unijuga* and *V. villosa*.

2) f. sp. *Viciae-unjugae*. This specialized form occurs on *Vicia unijuga* only. It has not been possible to transfer it to *Pisum sativum*, *Vicia Faba*, *V. hirsuta* and *V. nipponica* var. *capitata*.

#### *Uromyces Ervi*

Experiments were undertaken to ascertain whether forms of *Uromyces Ervi* can infect various species of *Vicia*, *Lathyrus* and *Pisum*, belonging to the *Vicieae* which are the host plants of *Uromyces Fabae* and *U. Orobi*.

##### 1. Inoculations with the aecidiospores on *Vicia hirsuta*

a. *Experiments in 1930*. (Experiment nos. 87 & 88). The aecidiospores of the present species on leaves of *Vicia hirsuta* which had been collected by the writer at Tottori on April 23 were inoculated on leaves of *Vicia Faba* and *V. hirsuta* on the same day. But no sign of infection appeared on *Vicia Faba*, while on the control plant, *Vicia hirsuta*, aecidia and uredosori appeared ten days after sowing.

b. *Experiments in 1931*. The experiments were made in two series. The inoculating materials were used as shown in the following table.

TABLE 23  
Materials for inoculation experiments with aecidiospores of  
*Uromyces Ervi* on *Vicia hirsuta*

Series	Locality of collection	Date of collection	Collector
I	Tottori	April 24, 1931	the writer
II	Omokage-mura near Tottori	May 19, 1931	the writer

Inoculations were attempted on *Lathyrus maritimus*, *L. palustris* var. *lineaefolius*, *Pisum sativum*, *Vicia Faba*, *V. hirsuta*, *V. nipponica* var. *capitata*, *V. sativa*, *V. tetrasperma* and *V. unijuga*. The results obtained are as tabulated in the following table.

TABLE 24  
Results of inoculation experiments with aecidiospores  
of *Uromyces Ervi* on *Vicia hirsuta*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of aecidia or uredosori
89	<i>Vicia Faba</i>	April 24, 1931	—
90	<i>V. hirsuta</i>	April 24, 1931	May 3
91	<i>V. sativa</i>	April 24, 1931	May 5
92	<i>V. tetrasperma</i>	April 24, 1931	May 3
93	<i>Pisum sativum</i>	May 19, 1931	—
94	<i>Lathyrus maritimus</i>	May 19, 1931	—
95	<i>L. palustris</i> v. <i>lineaefolius</i>	May 19, 1931	—
96	<i>Vicia Faba</i>	May 19, 1931	—
97	<i>V. hirsuta</i>	May 19, 1931	May 30
98	<i>V. nipponica</i> v. <i>capitata</i>	May 19, 1931	—
99	<i>V. tetrasperma</i>	May 19, 1931	May 31
100	<i>V. unijuga</i>	May 19, 1931	—

The results given in the foregoing table, show that aecidia or uredosori are produced on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*, while on *Vicia Faba*, *V. nipponica* var. *capitata*, *V. unijuga*, *Lathyrus maritimus*, *L. palustris* var. *lineaefolius* and *Pisum sativum* inoculations are unsuccessful.

## 2. Inoculations with the uredospores on *Vicia hirsuta*

On April 23 and May 14, 1930, at Omokage-mura near Tottori, the writer and M. YOSHIDA collected the uredospores of this species on *Vicia hirsuta* for inoculating materials.

On April 28, the uredospores from materials collected five days before were sown on leaves of *Vicia Faba* and *V. hirsuta*, and on May 14, the spores from those collected on the same day were sown on leaves of *Vicia Faba*, *V. hirsuta* and *V. sativa*. The results of these experiments are shown in the following table.

TABLE 25  
Results of inoculation experiments with uredospores  
of *Uromyces Ervi* on *Vicia hirsuta*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of uredosori
101	<i>Vicia Faba</i>	April 28, 1930	—
102	<i>V. hirsuta</i>	April 28, 1930	May 8
103	<i>V. Faba</i>	May 14, 1930	—
104	<i>V. hirsuta</i>	May 14, 1930	May 24
105	<i>V. sativa</i>	May 14, 1930	May 25

As indicated above, positive results were readily secured on *Vicia hirsuta* and *V. sativa*, while on *Vicia Faba* the inoculations were unsuccessful.

### 3. Inoculations with the aecidiospores on *Vicia sativa*

In this series, aecidiospores on *Vicia sativa* which had been obtained from Ubeno-mura near Tottori on April 22, 1931, were used as an inoculum. Attempts were made to inoculate them on *Vicia Cracca* var. *japonica*, *V. Faba*, *V. hirsuta*, *V. sativa*, *V. tetrasperma* and *Pisum sativum*, and the results were recorded in the following table.

TABLE 26  
Results of inoculation experiments with aecidiospores  
of *Uromyces Ervi* on *Vicia sativa*

Experiment no.	Plants inoculated	Date of inoculation	Date of first appearance of aecidia or uredosori
106	<i>Pisum sativum</i>	April 24, 1931	—
107	<i>Vicia Cracca</i> var. <i>japonica</i>	April 24, 1931	—
108	<i>V. Faba</i>	April 24, 1931	—
109	<i>V. hirsuta</i>	April 24, 1931	May 5
110	<i>V. sativa</i>	April 24, 1931	May 4
111	<i>V. tetrasperma</i>	April 24, 1931	May 5

From the preceding table, it may be seen that aecidia or uredosori were produced on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*, while on the remaining plants the inoculations were unsuccessful.

#### 4. Inoculations with the uredospores on *Vicia sativa*

The uredospores on *Vicia sativa* from the same source as in the former experiment, were used as an inoculum on *Vicia Faba*, *V. hirsuta*, *V. sativa* and *V. tetrasperma* on April 25, 1931.

Positive results were secured on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*, while on *Vicia Faba* inoculations were unsuccessful. (Experiment nos. 112-115).

#### 5. Inoculations with the aecidiospores on *Vicia tetrasperma*

The aecidiospores on leaves of *Vicia tetrasperma* were collected by the writer at Tachikawa, Tottori on May 10, 1931, and after two days inoculations were made on *Vicia Faba*, *V. hirsuta*, *V. sativa* and *V. tetrasperma*. Ten to thirteen days after inoculation, aecidia or uredosori began to appear on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*, but no sign of aecidia nor uredosori appeared on *Vicia Faba*. (Experiment nos. 116-119).

#### 6. Inoculations with the uredospores on *Vicia tetrasperma*

The uredospores on *Vicia tetrasperma* obtained from the same source as in the experiments with the aecidiospores on the same plant, were used. Inoculations with them were made on *Vicia hirsuta* and *V. tetrasperma*, and positive results were obtained on both plants. (Experiment nos. 120 & 121).

#### 7. Conclusions

From the preceding experiments, the following conclusions may be drawn:

1) Cross inoculations with aecidiospores or uredospores of *Uromyces Ervi* on three different species of *Vicia*; viz. *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* were made. The results indicated that this fungus on each of the three hosts is entirely the same; and no specialization whatsoever exists among them.

2) It has not been possible to transfer the present fungus to *Pisum sativum*, *Lathyrus maritimus*, *L. palustris* var. *lineaefolius*, *Vicia Cracca* var. *japonica*, *V. Faba*, *V. nipponica* var. *capitata* and *V. unijuga*.



### Repeating aecidia of *Uromyces Ervi*

As already mentioned DIETEL (5) and JORDI (25) have reported concerning the repeating aecidia of *Uromyces Ervi*. Moreover, it has also been seen in the former chapter that the present species produces repeating aecidia in the writer's experiments.

In the following series of experiments, special observations on the repeating aecidia of this fungus were attempted in more detail.

#### Experiment 1

This experiment was begun on April 17, 1931. Inoculations with the aecidiospores from the primary aecidia with spermogonia of the present species on *Vicia hirsuta* collected by the writer at Tachikawa, Tottori were made on healthy seedlings of the same plant. The results are given in the following table.

TABLE 27  
Results of inoculation experiments with primary  
aecidiospores of *Uromyces Ervi*

Date of inoculation	Date of appearance of aecidia	Date of appearance of uredosori	Date of appearance of teleutosori
April 17, 1931	April 27	May 2	May 7

Eight days after inoculation, most of the inoculated leaves began to show yellowish coloured spots, and two days later, the secondary aecidia without accompanying spermogonia appeared. The aecidia became most abundant after two weeks. Then, on May 2, a number of uredosori appeared on the upper surface of leaves and on stems, five days later teleutosori began to be produced on stems or petioles.

#### Experiment 2

In this experiment, inoculations were made with the aecidiospores from the primary infection (Experiment 1) on the same plant, *Vicia hirsuta*. The process of development of the fungi was almost similar to that in Experiment 1, as shown in the following table.

TABLE 28  
Results of inoculation experiments with secondary  
aecidiospores of *Uromyces Ervi*-1

Date of inoculation	Date of appearance of aecidia	Date of appearance of uredosori	Date of appearance of teleutosori
May 2, 1931	May 11	May 12	May 17

### Experiment 3

Inoculations with the aecidiospores obtained from the secondary infection (Experiment 2) were made on the same plant. The same results as in Experiments 1 and 2, were obtained as follows:

TABLE 29  
Results of inoculation experiments with secondary  
aecidiospores of *Uromyces Ervi*-2

Date of inoculation	Date of appearance of aecidia	Date of appearance of uredosori	Date of appearance of teleutosori
May 14, 1931	May 21	May 20	May 26

In these experiments, the writer also observed that this fungus commonly produces the teleutospores by infection with the aecidiospores, without any preceding development of uredospores. Especially, it seems that the present fungus goes directly from aecidia to teleutospores; the entire uredostage may be omitted, when the condition of the host is unfavorable.

### Conclusions

From the foregoing experiments, we may safely deduce the following conclusions.

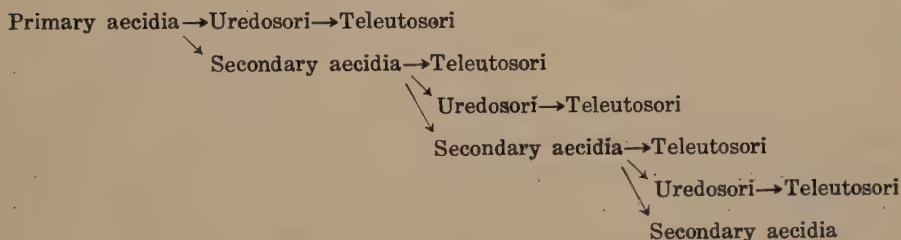
1) The first formed mycelium from basidiospore infection presumably develops spermogonia and aecidia. The aecidiospores give rise to a localized mycelium from which arise secondary aecidia without accompanying spermogonia.

2) The aecidiospores from the secondary aecidia then give rise to other similar infections, and the process may be repeated several times during a season.

3) Associated with these secondary aecidia, one finds uredo- and teleutosori in greater or less abundance.

4) It is not uncommon that the teleutospores give rise to a localized mycelium from the secondary aecidia.

Thus, from the above conclusions, the spore generation of *Uromyces Ervi* may be represented as in the following scheme.



As already mentioned in the foregoing pages, PLOWRIGHT (30) treated this fungus as an *Uromycopsis*, because its aecidia and teleutosori develop in great abundance in its life cycle, while the development of the uredosori is rather poor. But the writer does not agree with PLOWRIGHT's treatment, believing that it must be treated as an autoecious Eu-form, on account of the presence of the uredostage, though the development of this stage may be poor in its life cycle. However, it is considered that this fungus is a transitional form from Eu-form to -opsis form.

### Geographical distribution and host plants of *Uromyces Fabae*, *U. Orobi* and *U. Ervi* in Japan

#### *Uromyces Fabae* (PERS.) DE BARY

As far as the writer is aware, the occurrence of the present species on *Vicia Faba* L. was first recorded by DIETEL (7) from our country in 1900. He reported the uredostage of a rust fungus on a plant collected by S. KUSANO at the Botanical Garden of Tokyo Imperial University, as *Uromyces Fabae* (PERS.) in his "Uredineae japonicae II." Since then, it has been recorded by HENNINGS (17), ITÔ (24), YOSHINAGA (38), FUJIKURO (12), SAWADA (31), the writer (19, 23) and others from various districts throughout our country.

In 1901, HENNINGS (15) described a new species, *Uromyces Yoshinagai* on *Pisum sativum* L. The specimen, on which this species was based, was collected by YOSHINAGA from the province of Tosa. Afterwards, *Uromyces Yoshinagai* P. HENN. on *Pisum sativum* was recorded by HENNINGS (16), DIETEL (8), YOSHINAGA (37) and YOSHINO (40) from our country. In 1906, the SYDOWS and BUTLER (34) reported that *Uromyces Yoshinagai* is identical with *Uromyces Fabae*. It has been also treated by ITÔ (24), CUNNINGHAM (4) and the writer as a synonym of the latter species.

A form of this species on *Lathyrus maritimus* (L.) BIGEL was first recorded in 1899 by DIETEL (6) as *Uromyces Orobi* (PERS.) based on a specimen which was collected by KUSANO in the province of Iyo. In the next year, HENNINGS (14) recorded it from the same specimen as *Uromyces Fabae* (PERS.). In 1902, KUSANO (28) reported a rust fungus on the same plant collected at Hagi in the province of Nagato as *Uromyces Orobi*. Three years later, DIETEL (8) also identified an *Uromyces* on the same host collected by YOSHINAGA from the province of Tosa and another on *Lathyrus Davidii* HANCE collected by KUSANO on Mt. Fuji in the province of Suruga, both as *Uromyces Orobi* (PERS.) WINT.

In 1913, the SYDOWS (33) recorded *Uromyces Fabae* (PERS.) DE BARY on *Vicia Cracca* L. var. *japonica* MIQ. which was collected by M. MIURA at Sapporo.

In 1922, ITÔ (24) published a monograph of Japanese species of *Uromyces*, entitled, "Uromyces of Japan." In his detailed publication, the following eleven Japanese plants are reported as hosts of this species, based upon a large number of specimens preserved in the Herbarium of the Faculty of Agriculture, Hokkaidô Imperial University. They are: *Vicia amoena* FISCH., *V. Faba* L., *V. Fauriae* FRANCH., *V. Cracca* L., *V. pallida* TURCZ. var. *japonica* MAXIM. (*Vicia japonica* A. GRAY<sup>(1)</sup>), *V. pseudo-Orobis* FISCH. et MEY. (*Vicia Tanakae* FRANCH. et SAV.), *V. sativa* L., *V. tetrasperma* MOENCH., *V. venosa* MAXIM. (*Vicia deflexa* NAKAI), *Lathyrus maritimus* (L.) BIGEL and *Pisum sativum* L.

In 1924, TOGASHI (35) reported this species on *Vicia japonica* from Rebun Isl., the province of Kitami, and in the same year, he together with the writer (36) recorded the same species on the same host collected near Wakkanai also in Kitami province.

(1) The names in parentheses are added by the writer, being now considered the correct names as result of later studies.



Recently, this species on *Lathyrus maritimus* and *Vicia amoena* was recorded by the writer (20), and on *Vicia japonica*, *Lathyrus maritimus* and *L. palustris* var. *pilosus* by KAWAI and ÔTANI (26) from South Saghalien, on *Pisum sativum* and *Lathyrus maritimus* by the writer and YOSHIDA (23) from the neighbourhood of Tottori, on *Pisum sativum* and *Lathyrus maritimus* by YOSHINAGA and the writer (39) from the province of Tosa.

In Japan, the present fungus is very widely distributed, extending from South Saghalien to Formosa. The collections listed below have been examined by the writer.

f. sp. *Viciae-Fabae*.

On *Vicia Faba* L. (*Sora-mame*).

*S. Saghalien*.—Konuma (IX, 1930, T. ISHIYAMA; X, 1930, N. SHIRASAKA).

*Hokkaidô*.—Prov. Ishikari: Sapporo (VIII, 1919, T. FUKUSHI; VIII, 1894, Naoharu HIRATSUKA; VIII, 1924, Naohide HIRATSUKA; X, 1929, K. KAWAI; IX, 1929, M. SAKAMOTO; IX, 1923, S. ENOMOTO); Shiroishi-mura (VIII, 1926, Naoharu and Naohide HIRATSUKA); Kotoni-mura (VIII, 1929 and VIII, 1930, S. IWADARE). Prov. Teshio: Wassamu (X, 1924, Y. YAMANO). Prov. Kushiro: Akubetsu (Akan) (IX, 1925, Naohide HIRATSUKA, HIRATSUKA 1927, p. 232).

*Honshû*.—Prov. Hitachi: Mito (VII, 1931, K. WATANABE). Prov. Musashi: Komaba, Tokyo (VI, 1926, K. WATANABE). Prov. Sagami: Kamakura (VI, 1931, M. SHIMAMURA); Tamanawa-mura (V, 1928, Y. MIZUSAWA). Prov. Suruga: Kambaramachi (II, 1930, K. HARA). Prov. Shimotsuke: Utsunomiya (VII, 1931, E. AMANO). Prov. Etchû: Inazumi-mura (VI, 1931, S. IWAYAMA). Prov. Yamashiro: Kyoto (VI, 1895, Naoharu HIRATSUKA, Itô 1922, p. 239; VI, 1924, K. TOGASHI; VI, 1925 and VI, 1927, T. ABE; VI, 1927 and VI, 1928, S. ENDÔ). Prov. Yamato: Unebi (VI, 1931, J. MURATA). Prov. Bizen: Okayama (V, 1931, M. YOSHIDA). Prov. Bitchû: Kurashiki (V, 1930, Y. UEMURA). Prov. Inaba: Yoshioka-mura (VI, 1930, Naohide HIRATSUKA); Omokage-mura (V, 1930, Naohide HIRATSUKA and M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 574); Ubeno-mura (V, 1930, Naohide HIRATSUKA); Tottori (VI, 1929; IV, V, 1930 and IV, 1931, Naohide HIRATSUKA); Seijô-mura (VI, 1930, Naohide HIRATSUKA). Prov. Hôki: Daisenji (VII, 1931, Naohide HIRATSUKA, HIRATSUKA 1932, p. 31). Prov. Izumo: Koshi-mura (VI, 1923, K. YOKOGI).

*Shikoku*.—Prov. Tosa: Nagaoka-mura (VI, 1931, H. ASUYAMA); Kawakita-mura (VI, 1905, T. YOSHINAGA, Itô 1922, p. 239; YOSHINAGA and HIRATSUKA 1930, p. 629); Kôchi-shi (VI, 1902, T. YOSHINAGA, YOSHINAGA and HIRATSUKA 1930, p. 629); Kusaka-mura (V, 1902, T. YOSHINAGA, HENNINGS 1905 a, p. 594; YOSHINAGA 1904, p. (36); YOSHINAGA and HIRATSUKA 1930, p. 629). Prov. Iyo: Yoshida-machi (V, 1932, K. KIMURA).

*Kiushû*.—Prov. Hiuga: Miyazaki (V and VII, 1930, T. KATô; V, 1930, Y. KIKUCHI); Miyakonojô (V, 1931, M. SAHO). Prov. Satsuma: Kagoshima (VI, 1923, and V, 1931, T. Naitô; V, 1931, Y. IKEDA).

*Korea* :—Suigen (1916, N. NAKATA and K. TAKIMOTO, NAKATA and TAKIMOTO 1928, p. 111).

*Formosa* :—Prov. Taichû: Taichû (VI, 1930, F. ÔNUMA). Prov. Taihoku: Taihoku (IV, 1932, Y. HASHIOKA).

On *Pisum sativum* L. (*Endô*).

*Hokkaidô* :—Prov. Ishikari: Shiroishi-mura (VIII, 1926, Naoharu and Naohide HIRATSUKA).

*Honshû* :—Prov. Tôtômi: Mukasa-mura (VI, 1930, K. HARA). Prov. Inaba: Ubeno-mura (VI, 1930, Naohide HIRATSUKA); Omokage-mura (V and VI, 1930, M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 574; VI, 1931, Naohide HIRATSUKA).

f. sp. *Pisi-sativae*.

On *Pisum sativum* L.

*Honshû* :—Prov. Inaba: Ubeno-mura (V and VI, 1930, Naohide HIRATSUKA and M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 574); Seijô-mura (V, 1930, Naohide HIRATSUKA).

*Shikoku* :—Prov. Tosa: Mikazuki-mura (VI, 1910, T. YOSHINAGA, YOSHINAGA and HIRATSUKA 1930, p. 629); Kamo-mura (VI, 1901, T. YOSHINAGA, type of *Uromyces Yoshinagai* P. HENN., HENNINGS 1901, p. (124), as *Uromyces Yoshinagai* (type!); 1902, p. 729, as *Uromyces Yoshinagai*; YOSHINAGA 1902, p. (7), as *Uromyces Yoshinagai*; YOSHINAGA and HIRATSUKA 1930, p. 629; Itô 1922, p. 240); Nagaoka-mura (VI, 1931, H. ASUYAMA).

*Kiushû* :—Prov. Chikuzen: Fukuoka (K. TAKIMOTO).

f. sp. *Lathyri-maritimi*.

On *Lathyrus maritimus* (L.) BIGEL. (*Hama-endô*).

*S. Saghalien* :—Sakaehama (VII, 1927, Naohide HIRATSUKA, HIRATSUKA 1930, p. 65); Kushunnai (VIII, 1928, Naohide HIRATSUKA, HIRATSUKA 1930, p. 65); Kashipo (IX, 1929, Y. TOKUNAGA); Kita-Nayoshi (VIII, 1929, Y. TOKUNAGA and K. KAWAI).

*Hokkaidô* :—Prov. Ishikari: Ishikari (VII, 1923, Naohide HIRATSUKA).

*Honshû* :—Prov. Inaba: Fukube-mura (VI and XI, 1929, Naohide HIRATSUKA; V, 1930, Naohide HIRATSUKA and M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 574); Seijô-mura (VI, 1930, Naohide HIRATSUKA); Hamasaka near Tottori (V, 1930, M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 574). Prov. Kii: Shirahama (XII, 1931, Y. HASHIOKA).

*Shikoku* :—Prov. Tosa: Urado-mura (XII, 1906, T. YOSHINAGA, Itô 1922, p. 239; YOSHINAGA and HIRATSUKA 1930, p. 629); Ioki-mura (I, 1904, T. YOSHINAGA, DIETEL 1905, p. 93, as *Uromyces Orobi* (PERS.) WINT.; YOSHINAGA 1905, p. (36), as *Uromyces Orobi* (PERS.) WINT.; YOSHINAGA and HIRATSUKA 1930, p. 629).

*Kiushû* :—Prov. Satsuma: Toso near Kagoshima (IV, 1931, FUKUYAMA).

Forms whose biologic relations have not been investigated.

On *Vicia amoena* FISCH. var. *sachalinensis* FR. SCHM. (*Tsurufujibakama*).

*S. Saghalien*:—Ôdomari (VII, 1927, Naohide HIRATSUKA, HIRATSUKA 1930, p. 65).

*Hokkaidô*:—Prov. Iburi: Numanohata (IX, 1926, Naohide HIRATSUKA).

On *Vicia Cracca* L. var. *japonica* MIQ. (*Kusafuji*).

*S. Saghalien*:—Konuma (X, 1930, T. ISHIYAMA); Ôdomari (VII, 1927, Naohide HIRATSUKA).

*Hokkaidô*:—Prov. Ishikari: Sapporo (IX, 1920, T. FUKUSHI; X, 1895, K. MIYABE and Naoharu HIRATSUKA); Maruyama near Sapporo (IX, 1920, K. TOGASHI); Mt. Moiwa (X, 1922, Naohide HIRATSUKA); Makomanai (IX, 1929, K. KAWAI; X, 1924, Naohide HIRATSUKA). Prov. Tokachi: Urimakku (IX, 1929, K. KAWAI and M. SAKAMOTO). Prov. Kushiro: Rubeshibe (Akan) (VIII, 1923, Naohide HIRATSUKA).

On *Vicia japonica* A. GRAY (*Hiroha-kusafuji*).

*S. Saghalien*:—Akashiki (VIII, 1929, Y. TOKUNAGA and K. KAWAI, KAWAI and ÔTANI 1931, p. 238).

*Hokkaidô*:—Prov. Kitami: Oshidomari (Rishiri Isl.) (X, 1923, K. TOGASHI, TOGASHI 1924, p. 91); Noshappu-saki near Wakkanai (X, 1923, K. TOGASHI and Naohide HIRATSUKA, TOGASHI and HIRATSUKA 1924, p. 78).

On *Lathyrus palustris* L. var. *lineaefolius* SER. (*Renrisô*).

*Hokkaidô*:—Prov. Ishikari: Horomui (X, 1929, K. KAWAI and M. SAKAMOTO).

*Honshû*:—Prov. Rikuchû: Morioka (VIII, 1929, F. ÔNUMA).

A survey of scientific literature gives a number of additional localities and hosts in our country and adds materially to its distribution as shown by the herbarium materials examined.

On *Vicia amoena* FISCH. var. *sachalinensis* FR. SCHM.

*S. Saghalien*:—Horocho (Itô 1922, p. 239).

*Hokkaidô*:—Prov. Iburi: Chitose (Itô 1922, p. 239).

On *Vicia Cracca* L. var. *japonica* MIQ.

*Hokkaidô*:—Prov. Ishikari: Sapporo (Itô 1922, p. 239; SYDOW 1913, p. 94). Prov. Oshima: Kamiiso (Itô 1922, p. 239); Kikonai (Itô 1922, p. 239).

On *Vicia Faba* L.

*Hokkaidô*:—Prov. Ishikari: Nagayama (Itô 1922 p. 239); Chûbetsu (Itô 1922, p. 239).

*Honshû*:—Prov. Rikuzen: Sendai (ITÔ 1922, p. 239). Prov. Musashi: Tokyo (DIETEL 1900, p. 282; ITÔ 1922, p. 239). Prov. Owari: Nagoya (ITÔ 1922, p. 239); Chita (ITÔ 1922, p. 239). Prov. Yamashiro: Kyoto (ITÔ 1922, p. 239). Prov. Mino: Gifu (ITÔ 1922, p. 239). Prov. Harima: Himeji (ITÔ 1922, p. 239).

*Shikoku*:—Prov. Iyo: Dôgo (ITÔ 1922, p. 239).

*Kiushû*:—Prov. Higo: Ôtsu-machi (YOSHINO 1905, p. (105)); Kumamoto-shi (YOSHINO 1905, p. (102)); Demizu-mura (YOSHINO 1905, p. (102)).

*Formosa*:—Prov. Taihoku: Taihoku (FUJIKURO 1914, p. (2); ITÔ 1922, p. 239; SAWADA 1928, p. 39). Prov. Shinchiku: Kakubanzan (SAWADA 1928, p. 39); Takuran (SAWADA 1928, p. 39).

On *Vicia Fauriae* FRANCH. (*Tsugaru-fuji*).

*Hokkaidô*:—Prov. Oshima: Fukuyama (ITÔ 1922, p. 239).

On *Vicia japonica* A. GRAY (*V. pallida* TURCZ. var. *japonica* MAXIM.).

*Hokkaidô*:—Prov. Oshima: Kamiiso (ITÔ 1922, p. 239).

On *Vicia Tanakae* FRANCH. et SAV. (*V. pseudo-Orobis* FISCH. et MEY.) (*Ôba-kusafuji*).

*Honshû*:—Prov. Rikuchû: Morioka (ITÔ 1922, p. 239).

On *Vicia deflexa* NAKAI (*V. venosa* MAXIM.) (*Ebirafuji*).

*Honshû*:—Prov. Mutsu: Hachinohe (ITÔ 1922, p. 239). Prov. Rikuchû: Morioka (ITÔ 1922, p. 239).

On *Lathyrus maritimus* (L.) BIGEL.

*Hokkaidô*:—Prov. Ishikari: Ishikari (ITÔ 1922, p. 239). Prov. Shiribeshi: Okushiri (ITÔ 1922, p. 239).

*Honshû*:—Prov. Awa: Kiyosumi (DIETEL 1899, p. 570, as *Uromyces Orobis* (PERS.); HENNINGS 1900, p. 146; ITÔ 1922, p. 239).

On *Lathyrus palustris* L. var. *lineaefolius* SER.

*Honshû*:—Prov. Rikuchû: Asagishi-mura (ITÔ 1922, p. 239).

On *Lathyrus palustris* L. var. *pilosus* LEDEB. (*Yezo-no-renrisô*).

*S. Saghalien*:—Kashipo (KAWAI and ÔTANI 1931, p. 238); Akashiki (KAWAI and ÔTANI 1931, p. 238).

On *Pisum sativum* L.

*Honshû*:—Prov. Sagami: Ôyama (DIETEL 1905, p. 98, as *Uromyces Yoshinagai* P. HENN.).



As shown in the above, *Uromyces Fabae* (PERS.) DE BARY has with certainty been found in Japan on ten species, of which 1 belongs to *Pisum*, 2 to *Lathyrus* and 7 to *Vicia*.

### *Uromyces Orobi* (PERS.) LÉV.

In 1905, DIETEL (8) identified this species on *Lathyrus Davidii* HANCE. which was collected by KUSANO on Mt. Fuji in the province of Suruga, with *Uromyces Orobi* (PERS.) WINT. It is the first record of this species in our country. Five years after, he (9) reported a form of this species on *Vicia unijuga* A. BR. which was collected by YOSHINAGA from the province of Tosa as *Uromyces Fabae* (PERS.) WINT.

In 1922, ITÔ (24) identified an *Uromyces* on *Vicia unijuga* from the provinces of Tosa and Oshima with the present species. Since then, the fungus on this host has been treated as the present species by YOSHINAGA and the writer (39), the writer and YOSHIDA (23), and the writer (22). The writer and YOSHIDA (23) also recorded that this species occurs on *Vicia nipponica* MATSUM. var. *capitata* NAKAI in the vicinity of Tottori.

The collections listed below have been examined.

#### f. sp. *Viciae-nipponicae*.

On *Vicia nipponica* MATSUM. var. *capitata* NAKAI (*Tsuruyotsubahagi*).

*Honshû*: —Prov. Inaba: Ubeno-mura (XI, 1929 and V, 1930, Naohide HIRATSUKA and M. YOSHIDA; VI, 1930, M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 575; IX, 1930 and V, 1931, Naohide HIRATSUKA).

#### f. sp. *Viciae-unijugae*.

On *Vicia unijuga* A. BR. (*Nantenhagi, Taniwatashi*).

*Hokkaidô*: —Prov. Oshima: Esashi (X, 1922, Naohide HIRATSUKA).

*Honshû*: —Prov. Inaba: Ubeno-mura (XII, 1929, M. YOSHIDA; VI, 1930, Naohide HIRATSUKA and M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 575). Prov. Hôki: Daisen-mura (VII, 1929, M. YOSHIDA, HIRATSUKA 1932, p. 32).

*Shikoku*: —Prov. Tosa: Mt. Okô (I and II, 1908, T. YOSHINAGA, DIETEL 1910, p. 304, as *Uromyces Fabae* (PERS.) SCHRÖT.; ITÔ 1922, p. 242; YOSHINAGA and HIRATAUKA 1930, p. 630; XII, 1929, T. YOSHINAGA).

Form whose biologic relations have never been investigated.

On *Lathyrus Davidii* HANCE. (*Itachisasage*).

*Honshû*:—Prov. Rikuchû: Kuriyagawa near Morioka (VI, 1927, K. TOGASHI).  
Prov. Ômi: Mt. Ibuki (X, 1925, K. TOGASHI).

A survey of scientific literature gives a number of additional localities as follows.

On *Vicia unijuga* A. BR.

*Hokkaidô*:—Prov. Shiribeshi: Kudô (ITÔ 1922, p. 242). Prov. Oshima:  
Hakodate (ITÔ 1922, p. 242).

On *Lathyrus Davidii* HANCE.

*Honshû*:—Prov. Suruga: Mt. Fuji (DIETEL 1905, p. 98).

#### *Uromyces Ervi* (WALLR.) WEST.

In 1905, YOSHINO (40) listed an *Uromyces* on *Vicia hirsuta* KOCH and *V. sativa* L. as only "*Uromyces* sp." in his "A list of fungi collected in the province of Higo." It is the first record of *Uromyces Ervi* (WALLR.) WEST. from our country. In the same year, HENNINGS (17, 18) identified this rust fungus on *Vicia hirsuta* and *V. sativa* which were collected by YOSHINAGA in the province of Tosa, with *Uromyces Fabae* (PERS.) DE BARY. DIETEL (8) reported also in the same year a species of *Uromyces* on *Vicia hirsuta* from the province of Tosa, above mentioned, and that on the same host collected at Ôyama, the province of Sagami, as *Uromyces Ervi* (WALLR.) PLOWR., and a rust fungus on *Vicia sativa* L. from the province of Tosa as *Uromyces Fabae* (PERS.) SCHRÖT. Afterwards, ITÔ (24) also identified an *Uromyces* on *Vicia sativa* from the province of Tosa with *Uromyces Fabae*. ITÔ also reported the occurrence of *Uromyces Fabae* on *Vicia tetrasperma* MOENCH., based upon a specimen bearing only teleutospores from the province of Tosa.

The writer was able to examine these specimens on *Vicia sativa* and *V. tetrasperma* from the province of Tosa, and he found that these fungi are really *Uromyces Ervi*. Recently, this species on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* was recorded by YOSHINAGA and the writer (39) from the province of Tosa, on the three hosts by the writer and YOSHIDA (23) from the vicinity of Tottori, and on *Vicia tetrasperma* by the writer (22) from Mt. Daisen in the province of Hôki. The collections listed below have been examined.

On *Vicia hirsuta* KOCH (*Suzumenoendô*).

*Honshû*:—Prov. Sagami: Ôyama (VI, 1901, S. KUSANO, DIETEL 1905, p. 98). Prov. Settsu: Iwate-mura (VI, 1926, T. ABE). Prov. Kii: Seto (XII, 1930, Naohide HIRATSUKA). Prov. Bitchû: Kurashiki (V, 1930, Y. UEMURA). Prov. Inaba: Omokage-mura (V, 1930, M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 574); Tottori (IV, 1930 and VI, 1931, Naohide HIRATSUKA); Inabayama near Tottori (V, VI, 1930 and V, 1931, Naohide HIRATSUKA); Fukube-mura (V, 1930, Naohide HIRATSUKA); Yoshioka-mura (VI, 1930, Naohide HIRATSUKA); Seijô-mura (VI, 1930, Naohide HIRATSUKA). Prov. Tôtômi: Kawasaki-machi (V, 1926, K. HARA).

*Shikoku*:—Prov. Tosa: Aki-machi (IV and V, 1904, T. YOSHINAGA, DIETEL 1905, p. 98; Itô 1922, p. 241; YOSHINAGA and HIRATSUKA 1930, p. 628).

*Kiushû*:—Prov. Satsuma: Kagoshima (V, 1913, S. KAWAGOE).

On *Vicia sativa* L. (*Yahazuendô*, *Karasunoendô*).

*Honshû*:—Prov. Bitchû: Kurashiki (V, 1930, Y. UEMURA). Prov. Inaba: Tottori (IV, 1930 and VI, 1931, Naohide HIRATSUKA); Ubeno-mura (V, 1930, Naohide HIRATSUKA and M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 574); Inabayama near Tottori (VI, 1930, Naohide HIRATSUKA); Omokage-mura (V, 1930, M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 575); Yoshioka-mura (VI, 1930, Naohide HIRATSUKA).

*Shikoku*:—Prov. Tosa: Aki-machi (V, 1904, T. YOSHINAGA, DIETEL 1905, p. 98, as *Uromyces Fabae*; Itô 1922, p. 239, as *Uromyces Fabae*; YOSHINAGA and HIRATSUKA 1930, p. 628); Kôchi-shi (V and VI, 1902, T. YOSHINAGA, HENNINGS 1905 a, p. 594, as *Uromyces Fabae*; Itô 1922, p. 239, as *Uromyces Fabae*; YOSHINAGA and HIRATSUKA 1930, p. 628).

*Kiushû*:—Prov. Satsuma: Kagoshima (V, 1924, T. NAITÔ).

On *Vicia tetrasperma* MOENCH. (*Kasumagusa*).

*Honshû*:—Prov. Sagami: Ôyama (V, 1902, S. KUSANO). Prov. Suruga: Fujikawa-machi (IV, 1930, K. HARA). Prov. Settsu: Iwate-mura (VI, 1926, T. ABE). Prov. Bitchû: Kurashiki (V, 1930, Y. UEMURA). Prov. Inaba: Omokage-mura (V, 1930, M. YOSHIDA, HIRATSUKA and YOSHIDA 1930, p. 575); Tottori (IV, 1930 and IV, V, 1931, Naohide HIRATSUKA); Ubeno-mura (VI, 1930, Naohide HIRATSUKA); Fukube-mura (VI, 1929, Naohide HIRATSUKA); Seijô-mura (VI, 1930, Naohide HIRATSUKA). Prov. Hôki: Mt. Daisen (VII, 1931, Naohide HIRATSUKA, HIRATSUKA 1932, p. 31).

*Shikoku*:—Prov. Tosa: Ioki-mura (V, 1905, T. YOSHINAGA, Itô 1922, p. 239, as *Uromyces Fabae*; YOSHINAGA and HIRATSUKA 1930, p. 628).

*Kiushû*:—Prov. Satsuma: Okikoshima, Kagoshima Bay (X, 1925, T. NAITÔ).

As shown above, this species seems to be restricted mainly to the southern districts in our country. The writer is not aware of any record of the occurrence of this species in South Saghalien, Hokkaidô or the Kuriles.

TABLE 30  
Geographical distribution and host plants of *Uromyces Fabae*, *U. Orobi* and *U. Ervi* in Japan

Species	Host plants	S. Saghalien	Hokkaidô	N. Honshû	M. Honshû	S. Honshû	Shikoku	Kiushû	Formosa	Korea
<i>Uromyces Fabae</i>	f. sp. <i>Viciae-Fabae</i>		+	+	+	+	+	+	+	+
	f. sp. <i>Pisii-sativae</i>		+	+	+	+	+	+	+	
	f. sp. <i>Lathyræ-maritimi</i>		+	+	+	+	+	+	+	
	Forms whose biologic relations have not been investigated		+	+	+	+	+	+	+	
			+	+	+	+	+	+	+	
<i>Uromyces Orobi</i>	f. sp. <i>Viciae-nipponicae</i>		+	+	+	+	+			
	f. sp. <i>Viciae-unijugae</i>		+	+	+	+	+			
<i>Uromyces Ervi</i>	Form whose biologic relations have not been investigated		+	+	+	+	+	+	+	
			+	+	+	+	+	+	+	



## General summary

1. Comparative morphological studies of *Uromyces Fabae* and its allies on thirteen species of the Viciae have been conducted. They are: *Vicia amoena* FISCH. var. *sachalinensis* FR. SCHM., *V. Cracca* L. var. *japonica* MIQ., *V. Faba* L., *V. japonica* A. GRAY, *V. hirsuta* KOCH, *V. nipponica* MATSUM. var. *capitata* NAKAI, *V. sativa* L., *V. tetrasperma* MOENCH., *V. unijuga* A. BR., *Lathyrus Davidii* HANCE, *L. maritimus* (L.) BIGEL, *L. palustris* L. var. *lineaefolius* SER. and *Pisum sativum* L. From the results of the studies, the fungi on those different plants were divided morphologically into the following three distinct species.

a) *Uromyces Fabae* (PERS.) DE BARY on *Vicia amoena* var. *sachalinensis*, *V. Cracca* var. *japonica*, *V. Faba*, *V. japonica*, *Lathyrus maritimus*, *L. palustris* var. *lineaefolius* and *Pisum sativum*.

b) *Uromyces Orobi* (PERS.) LÉV. on *Vicia nipponica* var. *capitata*, *V. unijuga* and *Lathyrus Davidii*.

c) *Uromyces Ervi* (WALLR.) WEST. on *Vicia hirsuta*, *V. sativa* and *V. tetrasperma*.

2. A number of inoculation experiments with *Uromyces Fabae* (PERS.) DE BARY on different plants were made. From the resultant experimental data, the following three different specialized forms were established among a collective species, *Uromyces Fabae*.

a) f. sp. *Viciae-Fabae* on *Vicia Faba* and *Pisum sativum*. It has not been possible to transfer this form to *Astragalus sinicus* L., *Glycine Soja* BENTH., *Lathyrus Davidii*, *L. maritimus*, *L. odoratus* L., *Lotus corniculatus* L. var. *japonicus* RGL., *Phaseolus radiatus* L. var. *aurea* PRAIN, *Vicia atropurpurea* DESF., *V. Cracca* var. *japonica*, *V. hirsuta*, *V. monantha* RETZ., *V. nipponica* var. *capitata*, *V. pannonica* CRANTZ, *V. sativa*, *V. tetrasperma*, *V. unijuga*, *V. villosa* ROTH. and *Vigna sinensis* ENDL.

b) f. sp. *Pisi-sativae* on *Pisum sativum*. This form is highly specialized and did not transfer to *Lathyrus maritimus*, *V. Faba*, *V. hirsuta* and *V. tetrasperma*.

c) f. sp. *Lathyri-maritimi* on *Lathyrus maritimus*. It has not been possible to transfer this form to *Lathyrus Davidii*, *L. odoratus*,

*Vicia Cracca* var. *japonica*, *V. Faba*, *V. hirsuta*, *V. sativa* and *V. tetrasperma*.

3. A number of inoculations with *Uromyces Orobi* (PERS.) LÉV. on *Vicia nipponica* var. *capitata* and *V. unijuga* was made. From the data of these experiments, the two specialized forms; f. sp. *Viciae-nipponicae* and f. sp. *Viciae-unijugae* were established. The former is confined to *Vicia nipponica* var. *capitata*, and it does not infect on *Pisum sativum*, *Vicia atropurpurea*, *V. Cracca* var. *japonica*, *V. Faba*, *V. hirsuta*, *V. monantha*, *V. pannonica*, *V. sativa*, *V. tetrasperma*, *V. unijuga* and *V. villosa*. The latter one occurs on *Vicia unijuga* only, and it has not been possible to transfer it to *Pisum sativum*, *Vicia Faba*, *V. hirsuta* and *V. nipponica* var. *capitata*.

4. Cross inoculation experiments with aecidiospores and uredospores of *Uromyces Ervi* (WALLR.) WEST. on three different species of *Vicia*: *Vicia hirsuta*, *V. sativa* and *V. tetrasperma* were made. The results indicated that this species on each of the three hosts is entirely the same and no specialization exists among them. It has not been possible to transfer the present species to *Vicia Cracca* var. *japonica*, *V. Faba*, *V. nipponica* var. *capitata*, *V. unijuga*, *Pisum sativum*, *Lathyrus maritimus* and *L. palustris* var. *lineaefolius*.

5. *Uromyces Ervi* produces repeating aecidia in its life cycle. It is not uncommon that the teleutospores give rise to a localized mycelium from the secondary aecidia.

6. It is considered that *Uromyces Ervi* is a transitional form from Eu-form to -opsis form.

7. *Uromyces Fabae* is very widely distributed in Japan, extending from South Saghalien to Formosa. *Uromyces Orobi* is found in Hokkaidô, Honshû and Shikoku. *Uromyces Ervi* seems to be restricted mainly to the southern districts; southern Honshû, Shikoku and Kiushû in our country.

Finally, the writer wishes to acknowledge his indebtedness to Mr. Yasuo YOSHIDA and Mr. Masaji YOSHIDA for their faithful help on the present investigations.

BOTANICAL LABORATORY,  
TOTTORI AGRICULTURAL COLLEGE,  
TOTTORI, JAPAN

## Literature cited

1. ARTHUR, J. C.—North American Flora VII, pt. 3 (1912), pt. 11 (1926).
2. BUBÁK, F.—Infektionsversuche mit einigen Uredineen II. Bericht (1903). (Centralbl. f. Bakt. etc. II. Abt. **XII**, p. 411–426, 1904).
3. BUBÁK, F.—Die Pilze Böhmens I, Rostpilze (Uredinales), 1908.
4. CUNNINGHAM, G. H.—The rust fungi of New Zealand, 1931.
5. DIETEL, P.—Ueber zwei Abweichungen vom typischen Generationswechsel der Rostpilze. (Zeitschr. f. Pflanzenkr. **III**, p. 258–266, 1893).
6. DIETEL, P.—Uredineae japonicae I. (Engl. bot. Jahrb. **XXVII**, p. 564–576, 1 Taf., 1899).
7. DIETEL, P.—Uredineae japonica II. (*Ibid.* **XXVIII**, p. 281–290, 1900).
8. DIETEL, P.—Uredineae japonicae VI. (*Ibid.* **XXXVII**, p. 97–109, 1905).
9. DIETEL, P.—Uredineen aus Japan, III. (Ann. Myc. **VIII**, p. 304–314, 1910).
10. FISCHER, E.—Entwicklungsgeschichtliche Untersuchungen über Rostpilze. (Beiträge zur Kryptogamenflora der Schweiz, **I**, Heft 1, 1901).
11. FISCHER, E.—Die Uredineen der Schweiz. (Beiträge zur Kryptogamenflora der Schweiz, **II**, Heft 2, 1904).
12. FUJIKURO, Y.—A list of the rust fungi from Formosa. (Transact. Nat. Hist. Soc. Formosa, no. **19**, 1914). In *Japanese*.
13. GROVE, W. B.—The British Rust Fungi, 1913.
14. HENNINGS, P.—Fungi japonici II. (Engl. bot. Jahrb. **XXIX**, p. 146–153, 1900).
15. HENNINGS, P.—Einige neue japanische Uredineen II. (Hedwigia **XL**, p. (124)–(125), 1901).
16. HENNINGS, P.—Fungi japonici IV. (Engl. bot. Jahrb. **XXXI**, p. 728–742, 1902).
17. HENNINGS, P.—Fungi japonici V. (*Ibid.* **XXXIV**, p. 593–606, 1905a).
18. HENNINGS, P.—Fungi japonici VI. (*Ibid.* **XXXVII**, p. 156–166, 1905b).
19. HIRATSUKA, Naohide—A list of Uredinales collected in the vicinity of Lake Akan, Hokkaidô. (Transact. Sapporo Nat. Hist. Soc. **IX**, p. 225–238, 1927).
20. HIRATSUKA, Naohide—Erster Beitrag zur Uredineen-Flora von Südsachalin. (Mem. Tottori Agric. Coll. **I**, p. 63–98, 1930).
21. HIRATSUKA, Naohide—Relation between air temperature and the occurrence and development of the broad-bean rust. (Jour. Pl. Protect. **XIX**, p. 422–427, 1932). In *Japanese*.
22. HIRATSUKA, Naohide—Studies on the Uredinales of Mt. Daisen. (Transact. Tottori Soc. Agric. Sci. **IV**, p. 28–49, 1 table, 1932). In *Japanese*.

23. HIRATSUKA, Naohide and YOSHIDA, M.—Notes on *Uromyces Fabae* and its related species. (Jour. Pl. Protect. **XVII**, p. 571–578, 635–642, 716–721, 1930). In *Japanese*.
  24. ITÔ, S.—Uromyces of Japan. (Jour. Coll. Agric. Hokkaidô Imp. Univ. **XI**, p. 211–287, 3 pl., 1922).
  25. JORDI, E.—Beiträge zur Kenntnis der Papilionaceen bewohnenden *Uromyces*-Arten. (Centralbl. f. Bakt. etc. II. Abt. **XI**, p. 763–795, 1904).
  26. KAWAI, K. and ÔTANI, H.—A provisional list of fungi collected in southern Saghalien. (Transact. Sapporo Nat. Hist. Soc. **XI**, p. 227–242, 1931).
  27. KLEBAHN, H.—Uredineen. (Kryptogamenflora der Mark Brandenburg, **Va**, p. 69–904, 1912–1914).
  28. KUSANO, S.—On the distribution of the parasitic fungi in Chiugoku district. (Bot. Mag. Tokyo, **XVI**, p. (201)–(206), 1902). In *Japanese*.
  29. NAKATA, K. and TAKIMOTO, S.—Diseases of cultivated plants in Korea. (Jour. Agric. Exper. Stat. Govern.-General, Chosen, no. **15**, 1928). In *Japanese*.
  30. PLOWRIGHT, C. B.—A monograph of the British Uredineae and Ustilagineae, 1889.
  31. SAWADA, K.—Descriptive catalogue of the Formosan fungi, part IV. (Dept. Agric. Govern. Res. Inst. Formosa, Rept. no. **35**, 1928). In *Japanese*.
  32. SYDOW, P. & H.—Monographia Uredinearum, **II**, 1909–1910.
  33. SYDOW, P. & H.—Ein Beitrag zur Kenntnis der parasitischen Pilzflora des nördlichen Japans. (Ann. Myc. **XI**, p. 93–118, 1913).
  34. SYDOW, P. & H. and BUTLER, E. J.—Fungi Indiae orientalis, Pars I. (*Ibid.* **IV**, p. 424–445, 1906).
  35. TOGASHI, K.—Fungi collected in islands of Rishiri and Rebun, Hokkaidô. (Jap. Jour. Bot. **II**, p. 75–111, 1 pl., 1924).
  36. TOGASHI, K. and HIRATSUKA, Naohide—The parasitic fungi collected in the Noshappu Peninsula near Wakkanai, Hokkaidô. (Jour. Soc. Agric. & Forestr. Sapporo, **XVI**, p. 73–81, 1924). In *Japanese*.
  37. YOSHINAGA, T.—On some fungi from Tosa, II. (Bot. Mag. Tokyo, **XVI**, p. (1)–(7), 1902). In *Japanese*.
  38. YOSHINAGA, T.—On some fungi from Tosa, III. (*Ibid.* **XVIII**, p. (27)–(36), 1904). In *Japanese*.
  39. YOSHINAGA, T. and HIRATSUKA, Naohide—A list of Uredinales collected in the province of Tosa. (*Ibid.* **XLIV**, p. 627–667, 1930).
  40. YOSHINO, K.—List of fungi found in the province of Higo. (*Ibid.* **XIX**, p. (87)–(103), 1905). In *Japanese*.
-



## Explanation of plates XVI—XVII

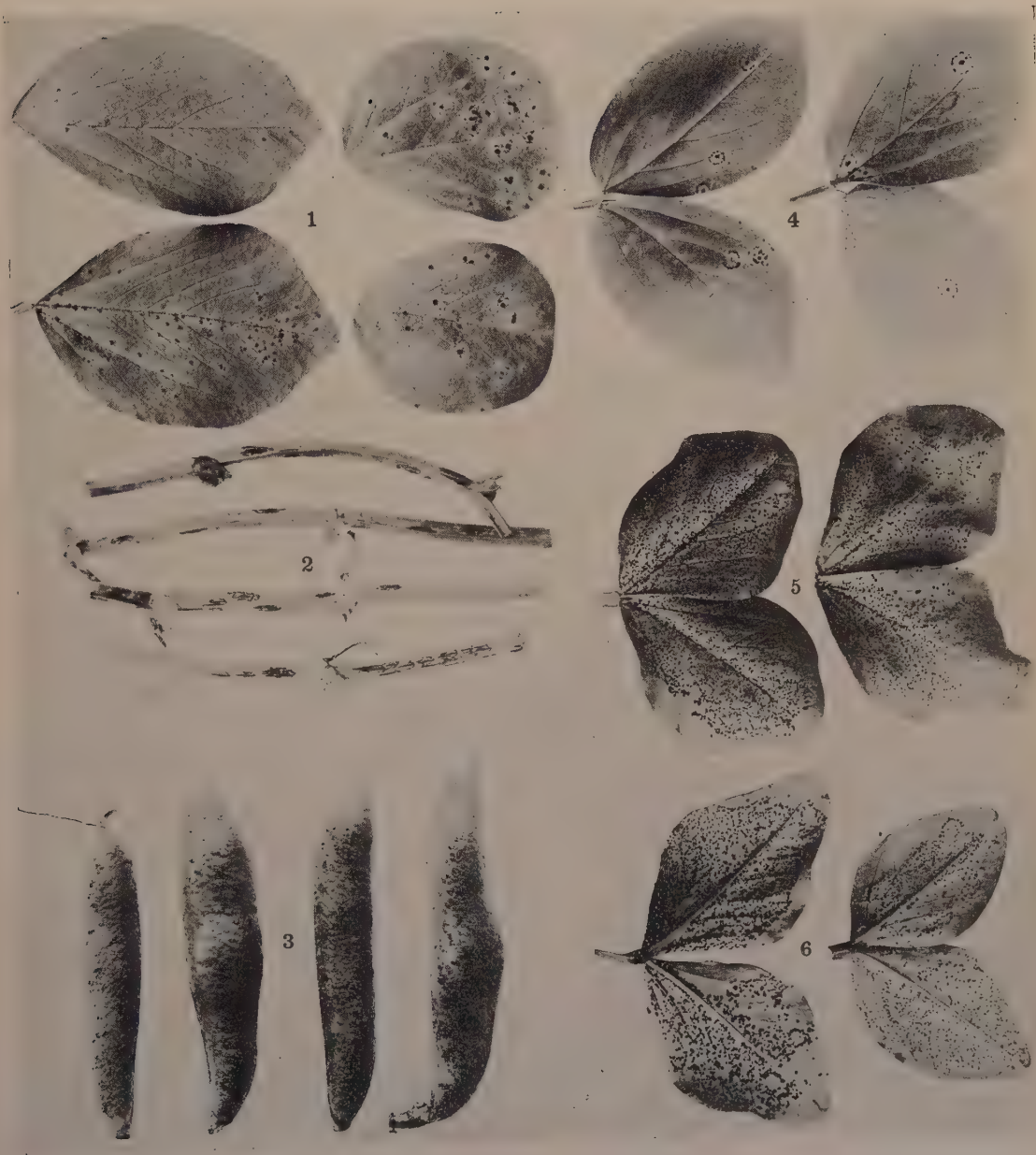
## PLATE XVI

- Fig. 1. Uredosori of *Uromyces Fabae*, f. sp. *Viciae-Fabae* on the upper surface of leaves of *Vicia Faba*.
- Fig. 2. Teleutosori of *Uromyces Fabae*, f. sp. *Viciae-Fabae* on stems of *Vicia Faba*.
- Fig. 3. Uredo- and teleutosori of *Uromyces Fabae*, f. sp. *Viciae-Fabae* on pods of *Vicia Faba*.
- Fig. 4. Circles of secondary uredosori around the primary uredosorus of *Uromyces Fabae*, f. sp. *Viciae-Fabae* on both surfaces of *Vicia Faba*.
- Fig. 5. Uredosori of *Uromyces Fabae*, f. sp. *Viciae-Fabae* produced by artificial inoculation on the upper surface of leaves of *Vicia Faba*.
- Fig. 6. Uredosori of *Uromyces Fabae*, f. sp. *Viciae-Fabae* produced by artificial inoculation on the under surface of leaves of *Vicia Faba*.

## PLATE XVII

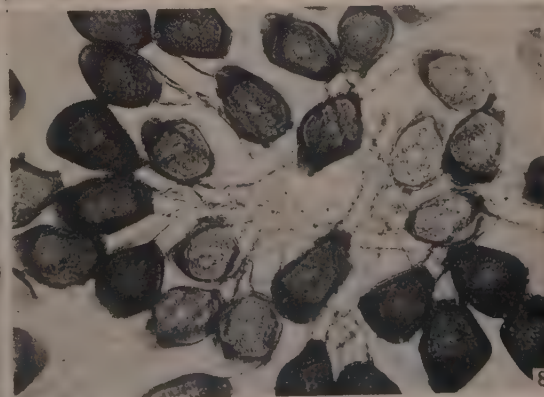
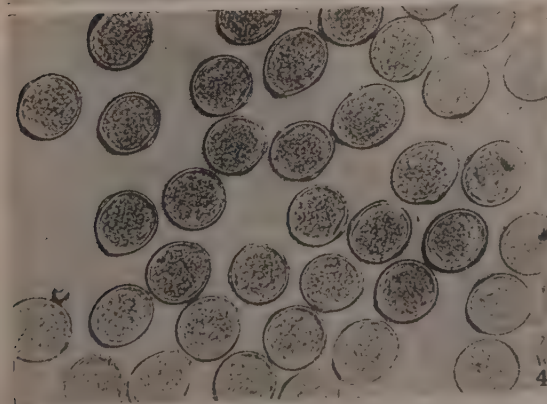
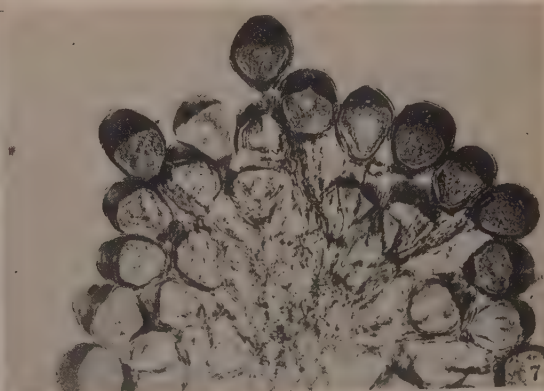
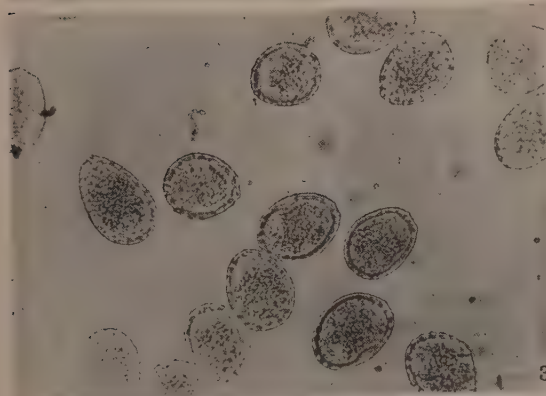
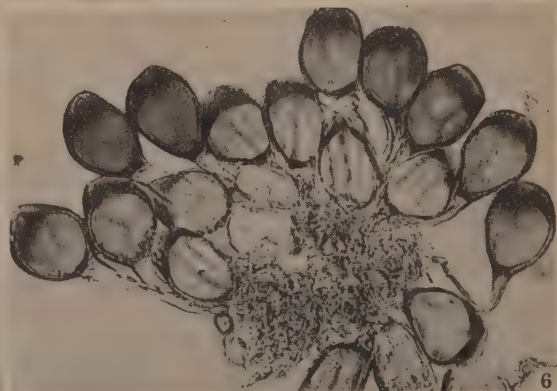
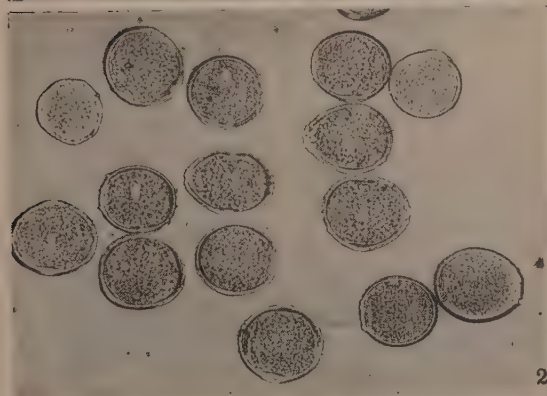
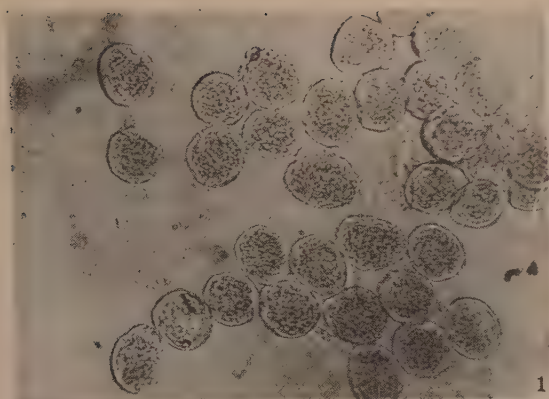
- Fig. 1. Aecidiospores of *Uromyces Ervi* on *Vicia hirsuta*.
- Fig. 2. Uredospores of *Uromyces Fabae*, f. sp. *Viciae-Fabae* on *Vicia Faba*.
- Fig. 3. Uredospores of *Uromyces Orobi*, f. sp. *Viciae-nipponicae* on *Vicia nipponica* var. *capitata*.
- Fig. 4. Uredospores of *Uromyces Ervi* on *Vicia hirsuta*.
- Fig. 5. Teleutospores of *Uromyces Fabae*, f. sp. *Viciae-Fabae* on *Vicia Faba*.
- Fig. 6. Teleutospores of *Uromyces Fabae*, f. sp. *Lathyri-maritimi* on *Lathyrus maritimus*.
- Fig. 7. Teleutospores of *Uromyces Orobi*, f. sp. *Viciae-nipponicae* on *Vicia nipponica* var. *capitata*.
- Fig. 8. Teleutospores of *Uromyces Ervi* on *Vicia hirsuta*.
-













# On some properties of the tobacco mosaic virus I

By Teikichi FUKUSHI

(Received December 5, 1932)

## Introduction

Although almost every conceivable hypothesis has been advanced as to the nature of the causative agent of the mosaic disease of tobacco, there exists no theory, in the writer's opinion, which is generally acceptable to plant pathologists. As has been discussed before (6) some of these hypotheses have been nearly discarded, while three of them are considered to be more significant since these suggest three different phases of the problem, which have been the subjects for investigations by many pathologists in recent years. These are chlamydozoa of PALM (1922) (15), HUNGER's (1905) (2) phytotoxin and allied views pointing to a certain enzyme-like substance, and the ultramicroorganism hypothesis suggested by ALLARD (1916) (1) and advocated by D'HERELLE (1924) (3).

PALM found certain foreign corpuscles and extraordinarily small granules in the cells of the mosaic diseased tissue of tobacco plant. He considered that these minute granules "agree in every respect with" the chlamydozoa of PROWAZEK (1907) (16) or organisms occupying an intermediate systematic position between protozoa and bacteria, that the foreign corpuscles are homologous with the Guarnieri bodies associated with variola, and further that these chlamydozoa represent the causal agency of the mosaic disease of tobacco. However, no convincing evidence has been obtained to prove that these minute granules represent the organisms which cause the disease. The foreign amoeboid corpuscles just mentioned were named X-bodies by GOLDSTEIN (1924) (7), suggesting that they may represent a living organism or perhaps an aggregate of living organisms. But it appears that certain pathologists incline to consider them as the reaction products of the affected cells. (IWANOWSKI, 1903 (10); PALM, 1922 (15); F. F. SMITH, 1926 (19); HOGGAN, 1927 (8); J. H. SMITH, 1930 (20); SHEFFIELD, 1931 (17)).



In recent years evidence has been accumulating to show that the infective principles of this disease consist of extraordinarily minute particles (DUGGAR and KARRER, 1921 (4); MULVANIA, 1926 (13); KLEBAHN, 1928 (11), 1931 (12)) of an enzyme-like substance. (FREIBERG, 1917 (5); MULVANIA, 1926 (13)). It may suggest the partial restoration of the phytotoxin hypothesis of HUNGER (1905) (9).

BEIJERINCK (1898) (2) considered that the virus of the tobacco mosaic was non-corpuscular but he nevertheless endowed it with one of the most striking properties of organisms, the power of reproduction. Because it was possible, by starting with an infinitesimally small quantity of the virus, to serially infect an endless number of plants, BEIJERINCK came to the conclusion that the virus must multiply. ALLARD (1916) (1) also considered that the virus was capable of increasing indefinitely within affected plants, and accordingly "there was every reason to believe that it is an ultramicroscopic parasite of some kind." However, it is not certain whether the virus reproduces itself or the host cell affected with the virus produces the virus in turn,—that is some abnormal metabolic product of the affected cell may function as the virus and stimulate it to develop the same product, which is the logical basis of the phytotoxin hypothesis.

In favor of the ultramicroorganism hypothesis are the results which have been obtained by the investigations of the specific relation between a certain virus disease of plant and its insect vector, for instance the curly top of sugar beet and *Eutettix tenella*, the aster yellows and *Cicadula sexnotata*, or the maize streak and *Cicadulina mbila*. The viruses of these diseases seem to require an incubation period within the insect carrier suggesting that some developmental changes of the virus occur within the insect before they are fully infective, and that they are in all probability of a living nature. Even supposing that these viruses are living organisms it does not indicate that the virus of the tobacco mosaic is animate, because there has been no definite evidence that these viruses and the infective principle of the tobacco mosaic stand within the same category.

Since the exceedingly small size of the infective particles of the tobacco mosaic disease has been demonstrated, an objection was raised against the ultramicroorganism hypothesis, stating that the infective principles are too small to represent an organism with the usual characteristics. Another view of contradiction against this



hypothesis is based upon the fact that the infectious agency is remarkably resistant to heat, ageing and toxic substances which destroy the ordinary microorganisms.

No body can deny with certainty the existence of organisms of ultramicroscopic dimensions, since the limits of microscopic visibility can not be the line of demarcation between living and non-living beings. But cellular organisms less than  $30\ \mu\mu$  in diameter are almost inconceivable<sup>(1)</sup>. Nevertheless it is not improbable that there exist non-cellular organisms, or semi-animate matter, so to speak, which "in part belong to the lowest forms of life" and "in part to the higher forms of ferments" as suggested by SIMON (1923) (18)—probably the "Probien" postulated by NÄGELI (1884) (14)—and that the virus of tobacco mosaic may find its position here. This will bring the two conflicting views, the enzyme hypothesis and the ultra-microorganism theory into harmony.

Under such circumstance, some intensive work is urgently needed in connection with the nature of the tobacco mosaic virus. A series of experiments is accordingly in progress in the hope of throwing some light on the nature of the virus. A part of the experimental results thus obtained will be presented in this paper.

The writer gratefully acknowledges here his indebtedness to Prof. emer. K. MIYABE and Prof. S. ITO for their valuable suggestions.

## I. Adsorption and elution of the virus

One of the difficulties which are encountered when one attempts to study the properties of the mosaic virus is the purification of the virus. Two different methods were employed in attempting to isolate the virus of the tobacco mosaic in a state as pure as possible, viz., by means of cataphoresis and by adsorption and elution processes. During the course of investigations the former method was discarded on account of its impracticability and the latter procedures alone

---

(1) If we assume that the infective particle of the tobacco mosaic possesses a diameter of  $30\ \mu\mu$  according to DUGGAR and KARRER, it can contain only less than 250 molecules of albumin, since the radius of egg albumin particles has been calculated to be  $2.4\ \mu\mu$  (HERZOG), assuming that the particles are spherical structures.

were followed. Several adsorbing materials including kaolin, silicious earth, iron oxide, aluminium oxide and aluminium hydroxide<sup>(1)</sup> were used to test the power of adsorption for the virus at different hydrogen ion concentrations and kaolin was employed in the adsorption and elution processes:

### Materials and methods

*Adsorption of the virus.* Thirty grams of fresh mosaic<sup>(2)</sup> tobacco leaves were cut up and ground in a mortar, adding 90 c.c. of tap water, until the leaf tissue was thoroughly crushed, then the juice was filtered off through two thicknesses of cotton, and through a CHAMBERLAND filter F under reduced pressure of approximately 755 mm. The filtered juice was a clear solution free from gross particles. To a known amount of the filtered juice, adjusting to the desired pH with one-tenth normal solution of  $\text{ClH}$  or  $\text{NaOH}$ , was added a known weight or volume of the adsorbing materials. The mixture was shaken for 10 minutes and filtered through Tôyô filter paper No. 6. The filtrates were inoculated into young tobacco plants.

*Elution of the virus.* To 45 c.c. of the filtered juice adjusted to an acid reaction, were added 2.3 gms. of purified kaolin<sup>(3)</sup>. The mixture was shaken for 10 minutes and filtered through the filter paper. The precipitates on the filter paper were then suspended in 15 c.c. of 0.08% ammonia solution in a small beaker and shaken for 10 minutes. The supernatant fluid adjusted to an acid reaction was filtered through the paper and used for inoculation purpose. All the determinations of pH were made by the quinhydrone electrode method.

*Inoculated plants.* The plants used for the inoculation were vigorously growing young tobacco plants of Bright Yellow variety with stems about 1–1½ inches high, that is some 3 months old in 5 inch pots.

*Technique of inoculation.* Three inoculations were made on each plant at the bases of as many young leaves. A large drop (approximately 0.5 c.c.) of the inoculum was placed with a sterile scalpel on the desired spot of the stem, and with a sterile needle about 30 pricks

(1) "Orthoaluminium hydroxide  $\gamma$ " of WILLSTÄTTER and his collaborators, (21), prepared according to their procedures.

(2) "Ordinary mosaic" of JOHNSON.

(3) Purified by WILLSTÄTTER and SCHNEIDER's method. (22)

were made through the fluid, thus working the latter into the tissue. Between different inoculations the needle was flamed while the hands were rinsed in water washing with soap.

### Experimental results

All the inoculations were performed in the late afternoon and then the floor of greenhouse was watered so as to prevent a rapid drying of the inoculated surface. The inoculated plants were kept under observation more than a month after inoculation. The results of experiments will be shown in the following tables.

#### a) *Adsorption of the virus*

As shown in table 1 alumina adsorbed the virus in the filtered juice of the mosaic tobacco leaves more readily than kaolin when the same amount of adsorbent was used, while silicious earth adsorbed the virus to no appreciable extent, when it was added in the concentration of 20 per cent. The virus was adsorbed by kaolin more readily in the filtered juice of an acid reaction, the pH value of which was less than 6.0. Aluminium hydroxide gel was effective to adsorb the virus. It may be worthy of note that alumina and Al-hydroxide gel adsorbed the pigments in the filtered juice more readily than kaolin or silicious earth. When the adsorbing materials were added to the filtered juice in the concentration of 10 per cent, alumina gave a colorless filtrate, while kaolin produced a filtrate pinkish buff to cinnamon buff (after RIDGWAY) in color and silicious earth a fluid of much darker color. There was a marked tendency indicating that kaolin or silicious earth adsorbed the pigments less easily in alkaline fluid. It appears, as shown in the table, that the filtered juice of the mosaic tobacco leaves which had been adjusted to an alkaline reaction was rendered less infectious by passing through filter paper. This admits two interpretations: either the virus may have been inactivated in alkaline fluid, or the virus or virus-bearing particles may have been coagulated and partly retained on the filter paper, a slight precipitate being produced in the fluid when a small amount of NaOH solution was added. The evidence seems to lend support to both views since the virus is so slightly inactivated in weak alkaline fluid that the experimental results shown in table 1 can not be explained merely based upon the former assumption.

TABLE 1. Effects of adsorbing materials on the infectivity of the filtered mosaic juice at different pH

Adsorbent	Concentration	pH of the filtrate		No. of plants		pH of the filtrate		No. of plants	
		Before adsorption	After adsorpt.	Inoculated	Affected	Before filtr.	After filtr.	Inoculated	Affected
kaolin	20%	4.1	4.1	7	0	—	—	—	—
"	"	4.9	4.8	7	0	4.9	4.8	7	6
"	"	5.4	5.0	7	0	5.4	5.2	7	7
"	"	5.7	5.3	7	0	5.7	5.5	10	10
"	"	6.1	5.5	10	1	6.1	5.9	10	10
"	"	6.5	5.5	10	3	6.5	6.3	10	10
"	"	6.7	5.7	7	5	6.7	6.6	7	7
"	"	7.9	7.0	7	2	7.9	7.7	7	6
"	"	8.0	6.8	7	2	8.0	7.8	7	5
"	"	8.5	6.9	7	1	8.5	8.4	7	4
"	"	6.3	4.9	7	7	6.3	6.1	7	7
"	10%	6.5	4.7	7	0	6.5	6.0	7	7
kao in, purified	20%	4.4	4.3	7	0	4.4	4.4	7	7
"	10%	5.0	4.5	7	0	5.0	4.9	7	7
"	"	6.0	5.1	7	2	6.0	5.9	7	7
"	"	6.5	5.1	7	3	6.5	6.0	7	7
"	"	7.7	5.8	7	4	7.7	6.7	7	7
"	"	4.3	4.2	7	0	—	—	—	—
"	5%	5.0	4.7	7	0	—	—	—	—
"	"	5.0	4.6	7	1	—	—	—	—
"	"	6.5	5.4	7	5	6.5	6.0	7	7





*b) Effect of different hydrogen ion concentrations  
upon the virus*

As already mentioned, the filtered juice of mosaic tobacco leaves which had been brought to an alkaline reaction was rendered less virulent by passing through filter paper. Accordingly a series of experiments was carried out to ascertain the effect of different H-ion concentrations upon the virus. The H-ion concentration of the filtered juice of mosaic tobacco leaves prepared by the before mentioned method, usually fell within the limits of pH 6.3 to 6.9 as determined by the quinhydrone electrode method. One-tenth normal solution of  $\text{ClH}$  or  $\text{NaOH}$  was added to the filtered juice to adjust the pH value and after 2 to 3 hours it was inoculated into young tobacco plants. The results of the experiments will be presented below in a tabulated form.

TABLE 2. Effect of different pH upon the infectivity of the virus in the filtered juice of mosaic tobacco leaves

Series 1				
pH of the fluid		No. of plants		percent, of infection
initial pH	final pH(*)	inoculated	affected	
2.0	2.0	7	3	43 %
2.6	2.7	7	3	43
3.1	3.1	7	5	71
3.7	3.6	7	7	100
	4.1	7	7	100
	4.5	7	7	100
	5.2	7	7	100
	5.5	7	7	100
	6.1	7	7	100
	6.3	7	7	100
	6.4	7	7	100
	6.5	7	7	100
	6.6	7	7	100
	6.9	7	7	100
	7.1	7	7	100
7.8	7.5	7	5	71
8.3	8.1	7	5	71

TABLE 2 (Continued)

Series 2				
pH of the fluid		No. of plants		percent. of infection
initial pH	final pH *	inoculated	affected	
2.1	2.0	7	1	14 %
2.5	2.5	7	4	57
2.9	2.9	7	6	86
3.4	3.4	7	6	86
3.8	3.8	7	6	86
4.4	4.3	7	7	100
4.9	4.9	7	7	100
6.1	6.1	7	7	100
6.5	6.7	7	7	100
7.8	7.3	7	7	100
8.5	7.9	7	5	71

\* pH of the inoculum

As shown above the virus in the filtered juice of mosaic tobacco leaves seems to be most virulent at pH 4-7 and to be rendered less active by increasing the alkalinity or acidity.

c) *Elution of the virus*

TABLE 3. Elution of the virus adsorbed by kaolin

pH of the acidified filtrate*	4.9	4.8	4.6	4.9	4.5	4.7
adsorbent	kaolin (purified) 5%	kaolin (purified) 5%	kaolin (purified) 5%	kaolin (purified) 5%	kaolin (purified) 5%	kaolin (purified) 5%
eluent	ammonia 0.06%	ammonia 0.08%	ammonia 0.08%	ammonia 0.08%	ammonia 0.08%	ammonia 0.08%
duration of elution	30 min.	60 min.	60 min.	10 min.	30 min.	120 min.
pH of the acidified eluate (before filtration)	3.8	5.0	6.5	6.3	5.3	4.8
MILLON'S reaction of the eluate **		+	++	+	+	—
No. of plants inoculated	7	20	15	20	10	10
No. of plants affected	6	10	13	8	9	4
percent. of infection	86%	50%	87%	40%	90%	40%

\* To 50 c.c. of the filtered juice were added 2 c.c. of one-tenth normal solution of ClH.

\*\* A few drops of the reagent were added to about 5 c.c. of the eluate in the test tube, which was then warmed on a flame to hasten the reaction. ++ denotes that the reaction was evident instantly and + shows that the precipitates were colored pinkish after they were left over night.

As shown in table 3, the virus can be removed from the kaolin precipitates and brought into solution again by dilute ammonia. The eluate was an entirely or nearly colorless solution, when young leaves were used as virus source, and contained a very small amount of tyrosine or phenolic substance which was demonstrated by MILLON's test. It gave, however, negative xantho-protein, BIURET and RAS-PAIL's reaction. As stated before, to 45 c.c. of the virus solution were added 2.3 grams of purified kaolin to adsorb the virus and 15 c.c. of dilute ammonia were used to elute the virus from the kaolin precipitate. If all the virus can be thus liberated, the eluate will become three times as virulent as the original virus solution. As a matter of fact, however the former was less infectious than the latter.

### Summary

The virus of tobacco mosaic disease was readily adsorbed by kaolin and alumina when these adsorbents were added to the amount of 10 to 20 per cent to the filtered juice of mosaic tobacco leaves. Aluminium hydroxide gel was also effective to adsorb the virus while silicious earth adsorbed it to no appreciable extent when it was added in the concentration of 20 per cent.

Kaolin adsorbed the virus more readily in the filtered juice of an acid reaction, the pH value of which was smaller than 6.0.

The virus adsorbed by kaolin was eluted from the latter by dilute ammonia and regained its virulence when the eluate was adjusted to a slightly acid reaction.

The virus was most virulent at pH 4 to 7 and rendered less infectious by increasing the alkalinity or acidity.

BOTANICAL INSTITUTE, FACULTY OF AGRICULTURE,  
HOKKAIDO IMPERIAL UNIVERSITY

---



## Literature cited

1. ALLARD, H. A.—Some properties of the virus of the mosaic disease of tobacco. *Jour. Agric. Res.* **6** (17): 649–674, illust. 1916.
2. BELJERINCK, M. W.—Über ein Contagium vivum fluidum als Ursache der Fleckenkrankheit der Tabaksblätter. *Verhandel. Kon. Akad. Wetensch. Amsterdam* **II 6** (5): 1–22, illust. 1898.
3. D'HERELLE, F.—Immunity in natural infectious disease. English ed. by G. H. Smith 399 p. 1924.
4. DUGGAR, B. M. and KARRER, J. L.—The sizes of the infective particles in the mosaic disease of tobacco. *Ann. Missouri Bot. Gard.* **8**: 343–356, 1921.
5. FREIBERG, G. W.—Studies in the mosaic diseases of plants. *Ann. Missouri Bot. Gard.* **4**: 175–232, illust. 1917.
6. FUKUSHI, T.—On the cause of the mosaic disease of tobacco. (In Japanese). *Agric. and Hort.* **4** (11): 1273–1283, illust. 1929.
7. GOLDSTEIN, B.—Cytological study of living cells of tobacco plants affected with mosaic disease. *Bull. Torrey Bot. Club* **51**: 261–273, illust. 1924.
8. HOGGAN, I. A.—Cytological studies on virus diseases of solanaceous plants. *Jour. Agric. Res.* **35**: 651–671, illust. 1927.
9. HUNGER, F. W. T.—Neue Theorie zur Aetiologie der Mosaikkrankheit des Tabaks. *Ber. Deutsch. Bot. Ges.* **23** (8): 415–418, 1905.
10. IWANOWSKI, D.—Über die Mosaikkrankheit der Tabakspflanze. *Zeitschr. Pflanzenkr.* **13**: 1–41, illust. 1903.
11. KLEBAHN, H.—Experimentelle und cytologische Untersuchungen im Anschluss an Alloiophyllie und Viruskrankheiten. *Planta, Arch. wissensch. Bot.* **6** (1): 40–95, illust. 1928.
12. KLEBAHN, H.—Fortsetzung der experimentellen Untersuchungen über Alloiophyllie und Viruskrankheiten. *Phytop. Zeitschr.* **4** (1): 1–36, illust. 1931.
13. MULVANIA, M.—Studies on the nature of the virus of tobacco mosaic. *Phytop.* **16** (11): 853–871, 1926.
14. NÄGELI, C. v.—Mechanisch-physiologische Theorie der Abstammungslehre. 822 p. 1884.
15. PALM, B. T.—De mozaiekziekte van de tabak een chlamydozoonose? (voorloopige mededeeling) Deliproefsta. *Medan-Sumatra Bull.* 15. 10 p. (English trans. 7–10) 1922.
16. PROWAZEK, S.—Chlamydozoa. I Zusammenfassende Übersicht. *Arch. Protistenkunde* **10**: 336–358, 1907.

17. SHEFFIELD, F. M. L.—The formation of intracellular inclusions in solanaceous hosts infected with aucuba mosaic of tomato. *Ann. Appl. Biol.* **18** (4): 471-493, illust. 1931.
18. SIMON, C. E.—The filterable viruses. *Physiol. Rev.* **3** (4): 483-508, 1923.
19. SMITH, F. F.—Some cytological and physiological studies of mosaic diseases and leaf variegations. *Ann. Missouri Bot. Gard.* **13**: 425-484, illust. 1926.
20. SMITH, J. H.—Virus diseases in plants. *Biol. Rev.* **5** (2): 159-170, 1930. [Original not seen].
21. WILLSTÄTTER, R., KRAUT, H., und ERBACHER, O.—Über isomere Hydrogele der Tonerde. (VII Mitteilung über Hydrate und Hydrogele) *Ber. Deutsch. Chem. Ges.* **58**: 2448-2458, 1925.
22. WILLSTÄTTER, R. und SCHNEIDER, K.—Zur Kenntnis der Invertins. *HOPPE-SEYLER's Zeitschr. Physiol. Chem.* **133**: 193-228 (See p. 200), 1924.

# Mikrochemische Untersuchungen an über 1,800 Jahre lange aufbewahrtem Holz—ein Beitrag zur Kohlenentstehungstheorie

Von Kametaro OHARA

---

Mit Tafel XVIII-XIX und 5 Textfiguren

---

(Eingegangen am 17. Januar 1933)

## 1. Einleitung

Nachdem schon festgestellt wurde, dass die Kohle aus Holz, insbesondere aus Holzzellwänden, entstanden ist, sind wir jetzt in der Lage, durch mikrochemische Untersuchungen der Holzzellwände, sowohl von rezentem als auch fossilem Holz, Näheres über ihre Entstehung zu erfahren. Es ist ja auch bekannt, dass man in den Geweben des Lignits verschiedene Stufen der Inkohlung beobachten kann, so dass dieser ein geeignetes Material für die Kohlenforschung liefert. Der Verfasser<sup>(1)</sup> hat daher über die Mikrochemie des Lignits bereits eine Reihe Untersuchungen ausgeführt, deren Zweck war, chemische Prozesse der Inkohlung im Lignit zu verfolgen. Bei den Untersuchungen fand der Verfasser manchmal, dass Lignite zu diesem Zweck wenig geeignet waren, da ihre Gewebe zu weit in der Inkohlung fortgeschritten sind, so dass der Uebergang zwischen den veränderten Geweben und denen vom rezenten Holz nicht deutlich erkannt werden kann. Es erschien daher wünschenswert, Untersuchungen am Holz, das sich im Zustand des Vermoderns befindet, vorzunehmen, da es sowohl unveränderte als auch verkohlte Gewebe in einem Holzstück enthält.

---

(1) K. OHARA, Braunkohle. **37** (1926), 1-3.

Glücklicherweise wurde mir ein Stück Holz von einem Sarge, das in einem über 1,800 Jahre alten Grab<sup>(1)</sup> in Korea gefunden wurde, von Herrn Dr. KOMATSU, Professor an der Universität in Kyoto geschenkt, dem ich für seine Freundlichkeit zum verbindlichsten Dank verpflichtet bin. Dieses Holzstück ist nicht nur an der Peripherie stark verkohlt, sondern enthält auch im Innern fast vollständige Gewebe des lebenden Holzes, so dass es zum oben erwähnten Zwecke das geeignetste Material bietet.

Das Holzstück zeigt dunkelgraue Farbe und weist unterm Mikroskop im Querschnitt des inneren Teils ringporige Holzstruktur auf. Auf Grund der Strukturmerkmale konnte es mit *Castanea pubinervis* SCHNEID. identifiziert werden.

Bei den Untersuchungen wurde das Holz nach KISSERScher Dampfmethode<sup>(2)</sup> mit einem Mikrotom geschnitten, da bei diesem Verfahren kein chemisches Reagenz vor dem Schneiden benutzt wird, so dass die chemischen Bestandteile des Holzes dabei nicht stark verändert werden. Für mikrochemische Untersuchungen, insbesondere bei Lignitforschung, habe ich daher diese Methode öfters mit Erfolg benutzt.

## 2. Gewebestrukturen und ihre Veränderungen

Die Gewebestrukturen des inneren Teils des Holzstückes unterscheiden sich von den Geweben des lebenden Holzes dadurch, dass die Markstrahl- und Holzparenchymzellen des ausgegrabenen Holzes mit schwarzem Inhalt ausgefüllt sind. (Taf. XVIII, Abb. 2.) Dieser schwarze Inhalt, welcher nichts anderes ist als Humusstoff, kommt manchmal auch in Holzfasern vor.

In der Peripherie des Holzstückes findet sich hingegen eine schwarze dicke Schicht, die nicht nur makroskopisch kohlig erscheint,

(1) In einer Gegend von Heijo in Korea hat man schon früher zahlreiche alte Gräber gefunden. Diese Gräber wurden bisher von vielen Archäologen studiert, die der Meinung sind, dass sie aus der Zeit von RAKURO (100 v. Chr.—500 n. Chr.) stammen. Das in vorliegender Arbeit untersuchte Material ist ein Holzstück von einem Sarg, der von Prof. Dr. HAMADA in einem Grab in dieser Gegend gefunden wurde. Herr Prof. HAMADA hat mir freundlicherweise brieflich mitgeteilt, dass dieser Sarg in einem 1,800–1,900 Jahre alten Grab gefunden wurde. Der Sarg fand sich in einem mit Wasser ausgefüllten Holzkasten, welcher 1–3 m tief unter der Tonerde aufbewahrt war.

(2) J. KISSER, Z. wiss. Mikroskopie. 43 (1926), 346.



sondern auch im Querschnitt auffallenderweise der Kohlenstruktur (Clarit) ähnliche rötlich-braune Gefüge zeigt. (Taf. XVIII, Abb. 1. k.) In diesem Teile kommen alle Gewebeelemente stark zerdrückt und deformiert vor, so dass ihre Identifizierung nur in Bezug auf die wenig zersetzten Formen in der zwischen ihm und dem inneren Holzteile liegenden Uebergangszone möglich ist.

Grosse Gefässe in diesem Teile sind mehr oder wenig flachgedrückt. (Taf. XVIII, Abb. 1.) Während sie in der Uebergangszone noch die ursprünglichen Zellformen erkennen lassen, obwohl sie in radialer Richtung stark abgeflacht sind (Taf. XVIII, Abb. 1. g'), zeigen sie im äussersten Teile kaum noch ihre Zellformen. (Taf. XIX, Abb. 7.) Andere dünnwandige Gewebeelemente zeigen wellenförmige Zellkonturen und sind mit braunem Inhalt ausgefüllt. In diesem stark zersetzten Teile unterscheiden sich im Querschnitt manchmal noch deformierte dünnwandige Gefässe und Markstrahlen (m), die in brauner homogener Grundmasse parallel laufen, bei denen die vollständigen Zellformen nicht mehr zu erkennen sind.

Es ist bemerkenswert, dass in diesem Teile die Markstrahlen und die dazwischen liegenden Gewebe nicht parallel, sondern etwas schräg zu den Geweben im inneren Holzteile, verlaufen. (Taf. XVIII, Abb. 1.) Diese Erscheinung zeigt jedenfalls, dass die Konsistenz der beiden Teile des Holzes nicht gleichmässig war, als es dem Druck von Aussen herausgesetzt war, so dass nur die äusseren Gewebe stark deformiert und in die schiefe Lage verschoben wurden. Wenn die Holzgewebe gleichmässig weich gewesen wären, hätte diese ziemlich scharfe Grenze zwischen den beiden Teilen und die Verschiebung der Gewebe im äusseren Teile nicht entstehen können. Es liegt daher die Vermutung nahe, dass die oberflächliche Schicht des Holzes zuerst durch chemische Wirkung weich gemacht und dann durch den herrschenden Aussendruck allmählich gepresst und deformiert wurde, während die innere Schicht wegen der grossen Elastizität der Zellwände nicht leicht dem Druck nachgegeben hat. Das Weichwerden des Gewebes ist wahrscheinlich der Verminderung von Cellulose in den Zellwänden des äusseren Teils zuzuschreiben, und die Lokalisierung dieser chemischen Veränderung in den beschränkten Gewebeschichten ist kolloidchemisch verständlich.

### 3. Mikrochemie der Zellwände des inneren Teils

Im Querschnitt durch das innere Holz unterscheiden sich zwei Gewebearten, die mikrochemisch verschiedenartig reagieren. Eine von diesen bilden dünnwandige bzw. parenchymatische Zellen, nämlich Holzparenchym, Markstrahlzellen und Tracheiden. Da diese im Querschnitt nicht genau voneinander unterschieden werden können, sind sie alle in vorliegender Arbeit als "dünnwandige Zellen" behandelt. Die andere Gewebeart besteht aus dickwandigen Zellen, d.h. Gefässen von engerem und weiterem Lumen und Holzfasern. Da auch diese Gewebe in mikrochemischer Hinsicht voneinander nicht zu unterscheiden sind, sind sie als "dickwandige Zellen" zusammengefasst.

Die mikrochemischen Reaktionen der Zellwände dieser Gewebearten und der betreffenden Gewebe im äusseren kohlgigen Teile bei Cellulose-, Lignin- und Pektinreagentien sind in der beigelegten Tabelle zusammengestellt. Aus der Tabelle ersieht man die chemische Eigenart jeder Lamelle der Zellwände des inneren Teils, wie in folgenden beschrieben ist.

#### (1) *Mittellamelle*

Das reichliche Vorkommen des Lignins in dieser Lamelle kann sowohl durch Färbung mit Säurefuchsin als auch durch Phlorogluzinsalzsäure- und MÄULE-Reaktion nachgewiesen werden, denn sie löst sich auf in  $\text{H}_2\text{O}_2$  + Ammoniak und nicht in 72%  $\text{H}_2\text{SO}_4$ . Es ist von nicht geringem Interesse, dass die Mittellamelle, trotz langjähriges Aufbewahrens unter der Erde, deutliche Phlorogluzinsalzsäure-Reaktion zeigt, während sie bei Ligniten kaum zu erkennen ist<sup>(1)</sup>. Die rote Färbung dieser Lamelle mit Rutheniumrot kann in diesem Falle auf Pektinreaktion zurückgeführt werden, obgleich diese Reaktion nicht immer eindeutig ist<sup>(2)</sup>.

#### (2) *Primäre Lamelle*

Durch Phlorogluzinsalzsäure- und MÄULE-Reaktion lässt sich auch hier Lignin erkennen. Ausserdem enthält diese Lamelle eine

---

(1) K. OHARA, l.c. 37 (1926), 2, (1929), 3.

(2) K. OHARA, l.c. (1929), 2.

Struktur- element  Reagenz	INNERER TEIL								ÄUSSERER TEIL				TEIL				Bemerkungen
	Zellinhalt	Mittellamelle	I		II		III		Zellinhalt	Mittellamelle	I		II		III		
			Parenchym	Sklerenchym	Parenchym	Sklerenchym	Parenchym	Sklerenchym			Parenchym	Sklerenchym	Parenchym	Sklerenchym	Parenchym	Sklerenchym	
Rutheniumrot		rot od. gelb	farblos	farblos	rot	rot	farblos	farblos	gelblich rot — keine Differenzierung								In der Uebergangszone Zellinhalt braun, Zellwände gelblich u. Mittellamelle rot.
H <sub>2</sub> SO <sub>4</sub> +J	weinrot, blau (Markstrahlzellen)	weinrot	farblos (?)	farblos (?)	grün	grün	farblos (?)	farblos (?)	orangerot	orangerot	orangerot	farblos	orangerot	grün	orangerot	grün	Alle Markstrahlzellen blau oder grün
Chlorzinkjod		orange gelb	gelb	gelb (m. grauem stich)	grau	gelb (m. grauem stich)	farblos od. unregelmässige orange gelbe Masse	farblos od. unregelmässige orange gelbe Masse									In den Markstrahlzellen des äusseren Teils hier und da violette Färbung.
72% H <sub>2</sub> SO <sub>4</sub>	ungelöst (runde Körper)	ungelöst	gelöst	gelöst	gelöst	gelöst	gelöst	gelöst		ungelöst	der gelblich braune Teil unverändert!						Im äussersten Teile Strukturen, die sogen. Gerinnungsstrukturen ähnlich sind.
Säurefuchsin	(braune substanz)	rot	schwach rot od. farblos (braune Substanz)				farblos	farblos			rötlich gelb						In der Uebergangszone brauner Inhalt in zerdrückten Zellen
Phloroglucin-Salzsäure		rot	gelblich rot	gelblich rot	gelblich	gelblich	farblos (?)	farblos (?)	manchmal rote runde Körper	rot	gelblich rot						
Mäule-Reaktion	gelb	tief rot	rot	rot	rot	rot	farblos	farblos	Runde Körper hier und da	rot, leicht löslich	unlöslich, rot od. farblos	unlöslich, rot od. farblos	löslich	keine od. schwache Reaktion	löslich	keine od. schw. Reaktion	Markstrahlzellen unverändert oder beginnen zu zerfallen.
H <sub>2</sub> O <sub>2</sub> +Ammoniak		schwer aber löslich	unlöslich						leicht löslich	leicht löslich	unlöslich	unlöslich	löslich	unlöslich	löslich	unlöslich	
Oxaminblau 4 R (metachromatische Färbung)		orangerot	blau od. violett (Am Rande der Löcher violett)				farblos od. braun (humifiziert)	farblos od. braun (humifiziert)	rötlich gelb								





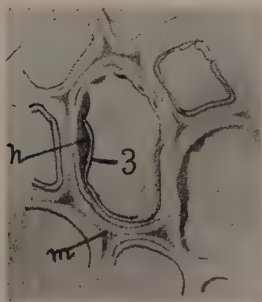
Substanz, die in  $\text{H}_2\text{O}_2$  + Ammoniak unlöslich und in 72%  $\text{H}_2\text{SO}_4$  löslich ist. Diese Substanz könnte Cellulose sein, da diese Lamelle nach vollständiger Beseitigung der Inkrusten durch Oxydationsmittel z.B.  $\text{H}_2\text{O}_2$  + Ammoniak, mit Chlorzinkjod tief violett gefärbt wird. Bei der Färbung mit Rutheniumrot und Methylenblau bleibt sie ungefärbt, obgleich die Sekundär- und Mittellamelle stark gefärbt werden, denn sie enthält weder Pektinstoff noch Oxycellulose. Da diese Lamelle so reichlich Lignin enthält, dass die Phlorogluzinsalzsäure- und MÄULE-Reaktion positiv ausfallen, bleibt sie nach Beseitigung der Cellulose durch Kupferoxydammoniak erhalten.

### (3) Sekundäre Lamelle

In dieser Lamelle kommt hauptsächlich Cellulose vor. Obgleich Rutheniumrot diese Lamelle rot färbt, kann man nicht ohne weiteres an das Vorhandensein von Pektinstoff denken, da Rutheniumrot als Membranfarbstoff nicht nur Pektin, sondern auch Oxycellulose rot färben kann<sup>(1)</sup>.

Es ist auffallend, dass die Lamelle, besonders in der Uebergangszone vom inneren zum äusseren Teile, öfters dunkelbraune

Farbe zeigt und meist so aufquillt, dass die dünne tertiäre Lamelle nach dem Zelllumen hin abgehoben oder manchmal zerissen wird. (Textfig. 1.) Diese Erscheinung kommt auch bei Kernholzbildung vor, worüber GURNIK<sup>(2)</sup> eine Reihe Untersuchungen ausgeführt hat. Er bestätigt die Meinung von TSCHIRCH, dass "bei der Bildung des Sekretes in den Leitungsbahnen des Kernholzes die sekundäre Membranlamelle auf kürzere oder längere Strecken eine Schleimmembranpartie entstehen lässt, die bewirkt, dass die tertiäre Membranlamelle, eine den Zellwänden innigst anliegende, äusserst feine Haut abgehoben wird." Jedenfalls verhält sich die Kernholzbildung mit der Zersetzung des Holzes unter der Erde ähnlich.



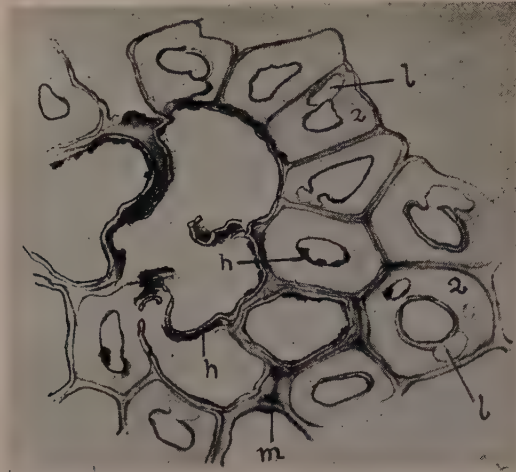
Textfigur 1. Dünnwandige Zellen im inneren Holzteile.  
Vergr. ca. 840x.

3. Tertiäre Lamelle. m. Mittellamelle. h. Humifizierte sekundäre Lamelle.

(1) K. OHARA, l.c. (1929), 2.

(2) W. GURNIK, Beiträge z. Kenntnis d. Kernholzbildung (Dissertation) Bern (1915).

Es ist auch von nicht geringerem Interesse, dass sich im Querschnitt dieser Lamelle besonders bei dickwandigen Zellen hie und da runde oder elliptische Löcher vorfinden. Diese Löcher stehen manchmal mit Tüpfeln bzw. dem Zelllumen in Verbindung und kennzeichnen die Korrodierung dieser Lamelle. (Textfig. 2.)



Textfigur 2. Dickwandige Zellen im inneren Teile. — Vergr. ca. 840×.

2. Sekundäre Lamelle. m. Mittellamelle. h. Humifizierte Lamelle.  
1. Löcher in d. sekund. Lamelle.

Aus den oben erwähnten Tatsachen lässt sich folgern, dass die Humifizierung des Holzgewebes bei der sekundären Lamelle beginnt. Dass diese Lamelle leicht bzw. zuerst zersetzt werden kann, kann durch folgende Befunde bewiesen werden.

Unter dem Polarisationsmikroskop zwischen gekreuzten Nikols ist diese Lamelle schon im lebenden Holz schwach doppelbrechend, während die primäre und die tertiäre Lamelle stärker leuchten. Dies beweist, dass die sekundäre Lamelle nicht so dicht wie die anstossenden Lamellen ist<sup>(1)</sup>.

Wenn man diese Holzgewebe mit Oxaminblau 4R färbt, zeigen die Zellwandlamellen eine Metachromasie, indem sich die Mittellamelle rot, die primäre und die sekundäre Lamelle schwach purpurn färben, während die tertiäre Lamelle farblos bleibt. Nach CZAJA<sup>(2)</sup> beruht diese Metachromasie auf der Dispersität der Farb-

(1) L. DIPPEL, Das Mikroskop. II. (1898), 264.

(2) A. CZAJA, Ber. d. d. b. G. 48 (1930), 100.

stoff-Teilchen, die je nach der Micellarstruktur an die passende Lamelle der Zellwände adsorbiert werden, so dass die Färbung die Dichtigkeit der Micellarstruktur der Lamelle zeigt. Die sekundäre Lamelle kann daher nicht so dicht sein wie die anderen Lamellen, da sie sich mit diesem Farbstoffe auch purpurn färbt, wie es immer bei den lockeren Parenchymzellwänden der Fall ist.

Betreffs der Ligninreaktion fällt die Säurefuchsinfärbung und Phlorogluzin-Reaktion bei dieser Lamelle negativ aus, während die MÄULE - Reaktion sehr deutlich ist. HARLOW<sup>(1)</sup> meinte, dass die MÄULE - Reaktion an der sekundären Lamelle der Holzzellwände keine wirkliche Ligninreaktion dieser Lamelle sei, demzufolge man mit diesem Mittel das Vorhandensein des Lignins in dieser Lamelle nicht konstatieren könne. Trotzdem ist RITTER<sup>(2)</sup> der Meinung, dass Lignin auch in dieser Lamelle vorkomme und dass dieses Lignin von dem der Mittellamelle durch Färbung, Formen und Methoxylgehalt zu unterscheiden sei. Soweit gehen die Meinungen über das Lignin in dieser Lamelle auseinander und es sind meiner Ansicht nach nähere Untersuchungen darüber nötig, so dass man vorläufig leider nicht leicht feststellen kann, ob Lignin in dieser Lamelle wirklich vorkommt, trotzdem dies für die Theorienbildung betreffs der Humifizierung des Holzes sehr wichtig ist.

Allerdings enthält diese Lamelle, insbesondere in den dickwandigen Zellen, nicht nur Cellulose, sondern auch Inkrusten, die durch Phlorogluzinsalzsäure- und Chlorozinkjodreaktion nachgewiesen werden.

#### (4) *Tertiäre Lamelle*

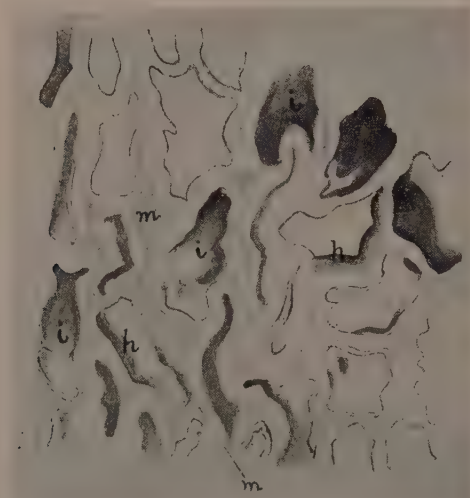
Diese Lamelle wird fast durch keinen Farbstoff gefärbt. Sie löst sich in 72%  $\text{H}_2\text{SO}_4$ , und nicht in  $\text{H}_2\text{O}_2$  + Ammoniak auf. Sie ist gegen Zersetzung beständig, so dass sie nicht nur in der Uebergangszone, sondern auch manchmal im äussersten Teile unzerstört und farblos bleibt, während die sekundäre Lamelle derselben Zellen schon früher zu Grunde gegangen ist. (Textfig. 3.) Diese Lamelle geht aber endlich in Humusstoff über, bevor die Mittellamelle die Ligninreaktion gänzlich verliert.

(1) W. HARLOW, Bull. New York State Coll. Forestry, Syracuse Univ. **1** (1928), 3.

(2) G. RITTER, Journ. Ind. Eng. Chemistry. **17** (1925), 11.

#### 4. Chemische Veränderung der Zellwände in der Uebergangszone zwischen dem inneren und dem äusseren stark zersetzten Teile

Wie oben erwähnt, findet man an der Oberfläche dieses Holzes eine schwarze kohlige Zone, welche im durchfallenden Licht rot-braune Gewebestreifungen, die an die mikroskopische Kohlenstruktur erinnern, zeigt. An der Innenseite dieser Zone erkennt man eine schmale Uebergangszone vom inneren zum äusseren Teile, in der die Holzzellen stark gedrückt und deformiert sind, obgleich ihre Gewebestruktur noch erkannt werden kann. (Textfig. 3.) In diesen zerdrückten Holzzellen, deren Zellwände wellenförmig gebogen sind,



Textfigur 3. Gewebe in der Uebergangszone.  
Vergr. ca. 840 $\times$ .

m. Mittellamelle. h. Humifizierte Lamelle.  
i. Zellinhalt.

tritt schwarz-braune Humussubstanz auf, die manchmal bei stark deformierten Zellen gänzlich das Zelllumen ausfüllt. Die Mittellamelle (m) wird in dieser Zone schon stark erweitert und tritt durch Säurefuchsin-Färbung deutlich hervor, da sie noch reichlich Lignin enthält. Es ist diese erweiterte Mittellamelle, die den Haupt-



bestandteil des äusseren kohligen Teils ausmacht. Es ist von grösstem Interesse, dass diese Erscheinung auch bei der Entstehung des Lignits eine grosse Rolle spielt <sup>(1)</sup>.

Die Reaktion dieses Gewebes in 72%  $\text{H}_2\text{SO}_4$  ist bemerkenswert. Da dieses Reagenz Cellulose von der Zellwand herauslöst, benutzt man es öfters für die Beseitigung dieser Verbindung, und dadurch für ihre Bestimmung. Durch diese Behandlung bleibt in den Zellwänden des dikotylen Holzes nur die Mittellamelle ungelöst, und an den Stellen, wo die sekundären Verdickungslamellen waren, kommen unregelmässige Klümpchen in geringer Menge vor. (Taf. XIX, Abb. 5.) HARLOW <sup>(2)</sup> meinte angesichts dessen, dass die sekundären Verdickungslamellen der dikotylen Holzzellwände kein Lignin enthalten und dass die unregelmässige Masse in den Zellen nach Beseitigung von Cellulose durch  $\text{H}_2\text{SO}_4$  nichts anderes sei als Plasmareste. Behandelt man aber das ausgegrabene Holz mit demselben Reagenz, so entstehen auffallenderweise, statt dieser unregelmässigen Klümpchen, runde Körper in den Zellen, während die Mittellamelle, wie beim lebenden Holz, ungelöst bleibt. (Taf. XIX, Abb. 6.) Diese runden soliden Körper, welche am reichlichsten in dieser Uebergangszone vorkommen, reagieren mit Chlorzinkjod gelb. Woher können sie nun stammen? Da die Mittellamelle bei der Reaktion unverändert geblieben ist, müssen sie aus sekundären Verdickungslamellen entstehen. Wenn aber die Annahme HARLOWS gerechtfertigt ist, dass die sekundären Verdickungslamellen kein Lignin enthalten, ist es ausgeschlossen, an die Abstammung dieser Substanz von Lignin zu denken, es muss sich also um eine metamorphosierte Substanz von Cellulose handeln. Trotzdem sind wir gegenwärtig nicht in der Lage, die Abstammung dieser Substanz festzustellen, solange die Meinungen über das Vorhandensein von Lignin in den Verdickungslamellen auseinander gehen. Jedenfalls ist bei diesen Lamellen eine grosse Veränderung ihrer chemischen Eigenschaften vor sich gegangen, so dass sie sich nicht mehr gänzlich in 72%  $\text{H}_2\text{SO}_4$  auflösen.

Bei der Oxydation mit  $\text{H}_2\text{O}_2$  + Ammoniak verschwindet der braune Inhalt der zusammengedrückten Zellen gänzlich, und die Zellwände quellen sehr stark, so dass die Zellen nicht mehr unregelmässige, sondern runde Querschnittformen zeigen.

Die wellenförmig deformierten Zellwände in dieser Zone gehen in die rötlich braune Grundmasse des stark zersetzten Teils über,

(1) K. OHARA, l.c. (1929), 1, 3.

(2) W. HARLOW, l.c.

wobei die Umrissse der Zellen und ihr Lumen allmählich undeutlich werden.

## 5. Mikrochemie des äusseren kohligen Teils

Wie schon oben erwähnt, besteht der äussere kohlige Teil hauptsächlich aus parallel laufenden Gewebesträngen aus zusammengepressten Gefässen und Markstrahlen, die sich in der rötlich braunen Grundmasse befinden. Diese ist nichts anderes als die zersetzten Zellwände dünnwandiger Holzzellen. Wahrscheinlich besteht sie chemisch aus Humusstoff, der sich in Kalilösung nicht auflöst.

Im polarisierten Licht bleibt diese Grundmasse bei gekreuzten Nikols dunkel, während die dicken Wände der Gefässe stark leuchten. Das beweist, dass Cellulose noch reichlich in den letztgenannten Teilen vorhanden ist. (Taf. XIX, Abb. 8.) Das Vorhandensein von Cellulose in diesem Teile kann auch durch  $H_2SO_4 + J$ -Behandlung nachgewiesen werden, indem die Gefässwände dabei grün gefärbt werden. Diese Reaktion kommt auch sowohl bei der inneren Wand der Markstrahlzellen als auch fleckenartig im noch stärker zersetzten Teile vor.

Wenn man aber mit  $H_2O_2 +$  Ammoniak Lignin und Humusstoffe beseitigt, was man sehr leicht erzielen kann, erkennt man im äussersten Teile nach der Reaktion eine Netzstruktur aus dünnwandigen Zellen, welche mit Chlorzinkjod violette Färbung liefert. (Textfig. 4.) Falls die Oxydation nicht stark genug ist, bleibt die Mittellamelle hie und da, insbesondere an den Ecken der Zellen ungelöst. Sie färbt sich mit Chlorzinkjod gelb.

Wenn man um einen Vergleich auszuführen, die Gewebe des inneren Teils mit Chlorzinkjod nach vollständiger Beseitigung des Lignins nach der oben erwähnten Methode behandelt, so kommt tief violette Färbung nur bei den Innenwänden der Markstrahlzellen und der primären Lamelle der sonstigen Gewebe zustande, während die Mittellamelle gänzlich farblos bleibt.

Es ist daher höchst wahrscheinlich, dass diese Netzstruktur im stark vermoderten Teile aus der primären Lamelle der Holzzellwände besteht, und dass die Cellulose in dieser fast unverändert bleibt.

Es ist auch bemerkenswert, dass der humifizierte Anteil mit reichlichem Lignin bei der Oxydation sehr leicht zum Verschwinden

gebracht wird, während die Gewebe im inneren Teile fast unverändert bleiben. Man unterscheidet im Querschnitte des ganzen Holzstückes bei dieser Behandlung zwei voneinander scharf abgegrenzte Gewebearten, nämlich ein inneres dickwandiges und ein äusseres dünnwandiges Gewebe, welche die schwach bzw. die stark zersetzten Teile des Holzes darstellen. (Taf. XIX, Abb. 9.)



Textfigur 4. Stark zersetztes Gewebe in kohligen Teile. Nach  $H_2O_2$ +Ammoniak-Behandlung. Vergr. ca. 440×.  
mk. Markstrahlzellen. g. Gefässe. t. Tüpfel.

Diese chemische Erscheinung tritt auch bei Einwirkung anderer Oxydationsmittel z.B. Kaliumpermanganat, auf. Bei der MÄULE-Reaktion, wobei das Gewebe zuerst mit Kaliumpermanganatlösung oxydiert und dann mit HCl gebleicht wird, lösen sich humifizierte Substanz und Lignin des äusseren Teils schnell und vollständig auf, so dass man auch hierbei zweierlei Gewebe, ein dickwandiges und ein dünnwandiges, wie im oben erwähnten Querschnitt, unterscheiden kann. Die teilweise humifizierten, dickwandigen Gefässe, die in ihren Wänden noch reichlich Cellulose enthalten, unterliegen bei der MÄULE-Reaktion auch einer starken Oxydation, so dass ihre Wände nach der Reaktion nicht mehr vollständig, sondern stellenweise

(1) K. OHARA, l.c. 1 (1929), 3.



korrodiert, ja sogar manchmal pulverisiert werden. (Textfig. 5.) Im äussersten Teile werden diese Gefässe dünnwandig (Textfig.



Textfigur 5. Markstrahlzellen und korrodierte Gefässe. MÄULE-Reaktion.

Vergr. ca. 440 $\times$ .

g. Gefässe. mk. Markstrahlzellen.

4.) oder verschwinden gänzlich. Markstrahlzellen werden auch in diesem Teile stark korrodiert, indem lange Strahlzellen manchmal spindelförmig erscheinen. Allerdings befinden sich die oben erwähnten Zellwände im Prozess der Humifizierung, so dass die bei Oxydation löslichen Humusstoffe stellenweise nachgewiesen werden.

Was nun den Ligninanteil in diesem Gewebe anbelangt, so reagieren fast alle Gewebe bei Behandlung mit Phlorogluzinsalzsäure gleichmässig rot. Näher betrachtet, findet man, dass der am stärksten gefärbte Teil die Mittellamelle ist. Diese ist nicht nur ligninhaltig, sondern auch stark erweitert. Manchmal finden sich runde Körper im Zelllumen, die auch mit Phlorogluzinsalzsäure rot gefärbt werden. Im Vergleich mit den Geweben von Ligniten ist es auffallend, dass die Mittellamelle dieses Holzes noch Lignin-Reaktion durch Phlorogluzinsalzsäure beibehält,

obgleich die Gewebestrukturen stark zerstört worden sind. Nach vollständiger Beseitigung der Cellulose aus den Geweben durch 72%  $H_2SO_4$  oder nach FREUDENBERGSchem Verfahren<sup>(1)</sup>, bleiben fast alle Gewebe ungelöst und die Strukturen des Ligninanteils und der Gewebe aus Humusstoff werden deutlicher. Die braune Grundmasse zwischen den Markstrahlen tritt besonders deutlich hervor, wenn sie nach FREUDENBERGSchem Verfahren behandelt und nachher mit Methylenblau gefärbt wird. (Taf. XVIII, Abb. 3.) Daraus geht hervor, dass Lignin und Humusstoffe wichtige Bestandteile der zersetzten Gewebe sind.

Im Querschnitte dieses Teils, welcher mit 72%  $H_2SO_4$  behandelt ist, lässt sich der Zersetzungsprozess des Lignin- und Humusanteils

(1) K. FREUDENBERG, H. ZOCHER u. W. DÜRR, Ber. d. d. c. G. 62 (1929), 1814.



in der Reihenfolge, in der er vor sich geht, erkennen. (Taf. XVIII, Abb. 4.) In der Uebergangszon (u) zeigen alle Zellen ihre runden Querschnittformen noch deutlich, während diese Zellformen in den darauffolgenden Zonen nur bei den Gefässen und Markstrahlen erkannt werden können. (1. 2.)

Auffallenderweise findet man bei der oben erwähnten  $H_2SO_4$ -Behandlung an der Peripherie des Querschnittes ein eigentümliches Gebilde, welches dem sogenannten Gerinnungsstruktur<sup>(1)</sup> in der Saproelkohle sehr ähnlich erscheint. Gewöhnlich besteht dieses Gebilde aus mit braunem Inhalt ausgefüllten weitleumigen Zellen. Manchmal entsteht es durch Zusammenschmelzen mehrerer humifizierter Zellen, und zeigt unregelmässige Umrisse. (Taf. XVIII, Abb. 4. s.) Durch  $H_2SO_4 + J$  ist dieses Gebilde gelb und durch Phlorogluzinsalzsäure rot gefärbt, denn in diesem zusammengedrückten Gewebe kommt noch Lignin vor:

## 6. Zuckerreaktion

Es ist theoretisch nicht unmöglich, Zucker als Zwischenprodukt der Holzvermoderung im humifizierten Holz zu finden, aber es ist sehr schwer, ihn im Holz mikrochemisch nachzuweisen, da er leicht zersetzlich ist. Trotzdem dies nur eine Möglichkeit war, konnte der Verfasser Zucker tatsächlich beim Lignit durch Phenylhydrazinsalzsäure nachweisen<sup>(2)</sup>. Bei dem Sargholz konnte aber keine Zuckerreaktion durch Phenylhydrazinsalzsäure erzielt werden. Bei FEHLINGscher Reaktion wurden aber rote  $Cu_2O$ -Kügelchen, sowohl im inneren als auch im äusseren Teile lokalisiert, erkannt. Im inneren Teile sind diese Kügelchen in Markstrahlzellen, insbesondere in den mit der rötlich reagierenden Substanz ausgefüllten Zellen, reichlich enthalten. Der braune Inhalt der Parenchymzellen weist auch bei der Reaktion diese Kügelchen auf. Im kohligen Teile, insbesondere in der Markstrahlzellen, treten diese roten Kügelchen sehr reichlich auf. Sie fehlen der gelben amorphen Grundmasse gänzlich. Auf Grund dieser Tatsachen kann man jedenfalls annehmen, dass bei dieser Zersetzung FEHLINGsches Reagenz reduzierende Substanz reichlich entstanden ist.

(1) R. POTONIE, Einführung in die allgemeine Kohlenpetrographie. (1924), 120.

(2) K. OHARA, l.c. (1929), 3, 4.

## 7. Aschenbild

Um die Verteilung des Aschenbestandteils im ausgegrabenen Holz zu ermitteln, wurden Querschnitte durch den inneren und den äusseren Teile auf einem Platinblech verascht und nach der Methode von OHARA und KONDO<sup>(1)</sup> in Kanadabalsam eingeschlossen. In den so hergestellten Aschenbildern lassen sich Gewebestrukturen deutlich erkennen, trotzdem das lebende Holz von *Castanea pubinervis* fast kein Zellwand-Aschenbild liefert. (Taf. XIX, Abb. 10. 11.) Im Aschenbild treten am deutlichsten die Markstrahlen als schwarze Linien hervor. Zwischen diesen schwarzen Markstrahllinien kommen netzförmige Gewebestrukturen vor, wenn sie auch nicht so vollständig wie beim intakten Gewebe sind. (Abb. 11.) Diese Gewebestruktur findet man nicht nur im Aschenbild des inneren Teils, (Abb. 11.) sondern in dem des äusseren kohligen Teils (Abb. 10.), trotzdem im letztgenannten Teile beim intakten Gewebe keine feine Gewebestruktur ohne weiteres erkannt werden kann. Daraus geht hervor, dass die Holzzellwände im Verlaufe der Zersetzung den Aschenbestandteil stark adsorbieren.

Dieses Ergebnis stimmt mit der Analyse des Holzes einer ca. 800 Jahre alten norwegischen Hafenlage überein, welches im stark zerfressenen äusseren Teile sehr reichlich (15,69%) Aschenbestandteil enthält.<sup>(2)</sup> Diese starke Adsorption muss aber schon früher an den Zellwänden der vollständigen Gewebe stattgefunden haben, bevor sie im äusseren Teile zusammengedrückt und deformiert wurden, sonst könnten die Gewebestrukturen nicht so deutlich im Aschenbild erkannt werden. Diese Erscheinung bestätigt auch meine Annahme, dass bei der Entstehung des kohligen Teils zuerst das Holz infolge von chemischer Einwirkung weich wird und dann dem Aussendruck unterliegt.

## Zusammenfassung

1. Um den Humifizierungsprozess des Holzes zu ermitteln, wurde ein Stück Holz eines über 1,800 Jahre alten Sarges aus

(1) K. OHARA u. Y. KONDO, Arch. d. Pharmacie (1931), 292.

(2) W. FUCHS, Chemie der Kohle, (1931), 51.

*Castanea pubinervis*, welches in einem alten Grab in Korea gefunden wurde, mikrochemisch untersucht.

2. In diesem Holzstück unterscheiden sich ein äusserer und ein innerer Teil. Der schwarze kohlige äussere Teil besteht aus zusammengedrückten Gefässen, Markstrahlen und dazwischenliegender rotbrauner Grundmasse, welcher an die Mikrostruktur der Steinkohle erinnert. Im inneren Teile sind die Gewebestrukturen des lebenden Holzes fast vollständig erhalten geblieben.

3. Die Zersetzungprozesse der Holzzellwände bei diesem Holz sind wie folgt:—

(a) Die Mittellamelle der Holzzellwände besteht hauptsächlich aus Lignin und ist resistenzfähig. Im Verlauf der Zersetzung erweitert sie sich und bildet den Ligninanteil des kohligen Teils.

(b) Die primäre Lamelle ist auch resistenzfähig und besteht hauptsächlich aus Lignin und Cellulose. Im stark zersetzten Teil bis zur Peripherie bleibt diese Lamelle unzerstört und nach Beseitigung der humifizierten Substanz gibt sie Chlorzinkjodreaktion.

(c) Die sekundäre Lamelle ist nicht von dichter Natur, so dass sie am leichtesten zersetzt wird. Die Humifizierung des Holzes beginnt bei dieser Lamelle.

(d) In der Uebergangszone vom inneren zum äusseren kohligen Teile findet man zusammengedrückte Zellen mit braunem Inhalt, der hauptsächlich durch Zersetzung der sekundären Lamelle entsteht.

(e) Die tertiäre Lamelle ist merklich resistenzfähiger als die sekundäre. Sie bleibt manchmal in der äusseren kohligen Schicht erhalten.

(f) Beim lebenden Holz von *Castanea pubinervis* lösen sich alle sekundären Verdickungslamellen in 72%  $\text{H}_2\text{SO}_4$  auf und hinterlassen im Zelllumen unregelmässige Klümpchen, während die Verdickungslamellen des ausgegrabenen Holzes bei derselben Behandlung gelbe Kügelchen im Zelllumen entstehen lassen. Diese Kügelchen bestehen wahrscheinlich aus Humusstoff, der aus den sekundären Verdickungslamellen der Zellwände entstanden ist.

(g) Der äussere kohlige Teil besteht hauptsächlich aus Humusstoff, Lignin der Mittellamelle und Cellulose der primären Lamelle. Dicke cellulosehaltige Gefässwände befinden sich in Zersetzungsprozess und zeigen verschiedene Stufen der Korrodierung ihrer Wände.

(h) An der Peripherie des kohligen Teils lassen sich durch  $H_2SO_4$  Behandlung eigentümliche Strukturen erkennen, die der sogenannten Gerinnungsstruktur der Steinkohle ähnlich erscheinen. Sie sind nichts anderes als humifizierte Zellwände und geben Phlorogluzin-Reaktion.

(i) Die zersetzten Zellwände adsorbieren reichlich anorganische Salze, so dass im Aschenbild des Sargholzes deutliche Gewebestrukturen erhalten bleiben, während die Holzgewebe von *Castanea pubinervis* fast kein Aschenbild geben.

(j) Auf Grund der schiefen Strukturverschiebung der zersetzten Gewebe an der Holzoberfläche und des Auftretens von deutlichen Gewebestrukturen dieses Teils im Aschenbild liegt der Gedanke nahe, dass dieser kohlige Teil erst dann dem Aussen- druck unterlegen ist, nachdem er schon vorher chemisch weich geworden war.

AUS DEM INSTITUT FÜR WARENKUNDE DER  
HANDELSHOCHSCHULE ZU NAGOYA

---

### Nachtrag

Kürzlich hat HARLOW seine frühere Ansicht dahin verändert, dass Lignin auch in sekundären Verdickungslamellen vorkomme, obgleich es am reichlichsten in der Mittellamelle vorhanden sei. Man ist trotzdem noch nicht in der Lage, die Abstammung des runden Körpers in den mit 72%  $H_2SO_4$  behandelten Holzzellen (S. 401) festzustellen, da das von HARLOW gefundene Lignin in den sekundären Lamellen nicht so reichhaltig ist, dass es durch Oxydation das betreffende das Zelllumen erfüllende Produkt entstehen lässt. (Am. Journ. Bot. 19 (1932), 729-739).



### Tafelerklärung

Abkürzungen:—k. Äusserer kohliger Teil. i. Innerer Teil. g. Gefässe.  
m. Markstrahlen. u. Uebergangszone.

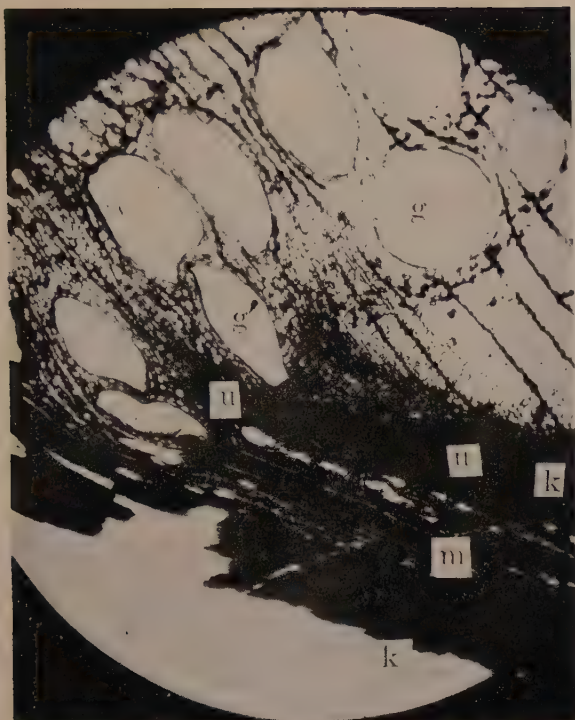
#### TAFEL XVIII

- Abb. 1. Querschnitt durch das ausgegrabene Sargholz von *Castanea pubinervis* SCHNEID. ca.  $\times 50$ .
- Abb. 2. Querschnitt durch den inneren Teil desselben Holzes. ca.  $\times 100$ .
- Abb. 3. Querschnitt des äusseren Teils, gefärbt mit Methylenblau nach FREUDENBERG'schem Verfahren. ca.  $\times 100$ .
- Abb. 4. Querschnitt des äusseren Teils, behandelt mit 72%  $H_2SO_4$ . An der Peripherie sieht man ein eigentümliches Bild, welches der Gerinnungsstruktur der Kohle ähnlich erscheint. (s) ca.  $\times 100$

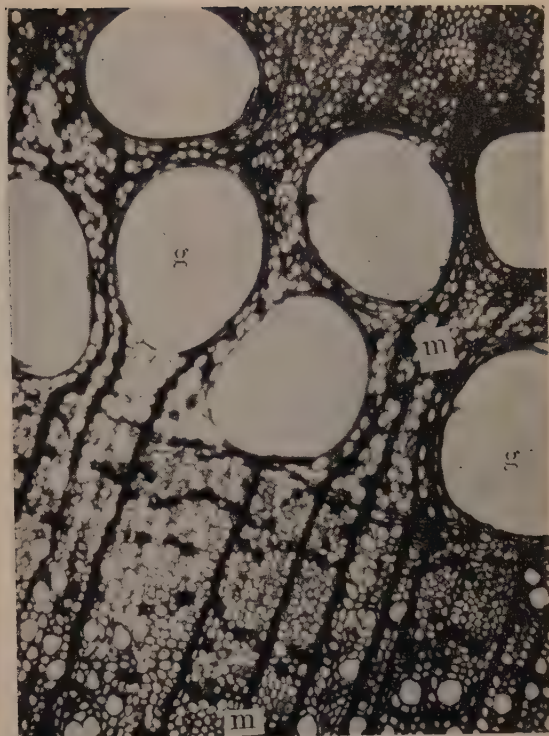
#### TAFEL XIX

- Abb. 5. Holzzellen aus lebender *Castanea pubinervis*. Nach Behandlung mit 72%  $H_2SO_4$ . Unregelmässige Klümpchen im Zelllumen. ca.  $\times 330$ .
- Abb. 6. Holzzellen vom ausgegrabenen Holz. Nach derselben Behandlung. Runde Kügelchen in den Zellen. ca.  $\times 330$ .
- Abb. 7. Gewebe vom äusseren kohligen Teile. REICHERT's Polarisationsmikroskop. II  $\times$  Zeiss D.
- Abb. 8. Dieselben bei gekreuzten Nikols. Wie oben.
- Abb. 9. Querschnitt des ausgegrabenen Holzes, bei MÄULE-Reaktion. ca.  $\times 75$ .
- Abb. 10. Aschenbild eines Querschnitts durch das ausgegrabene Holz. Äusserer kohliger Teil. ca.  $\times 150$ .
- Abb. 11. Wie oben. Innerer Teil. ca.  $\times 150$ .
-





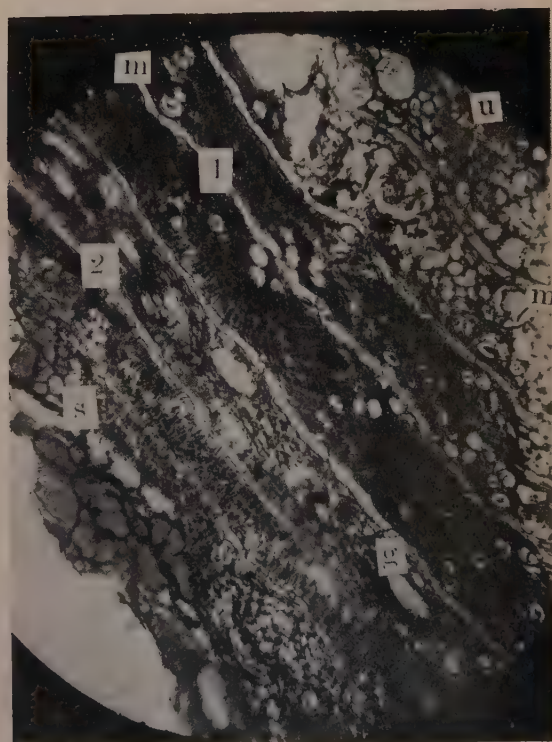
1



2



3



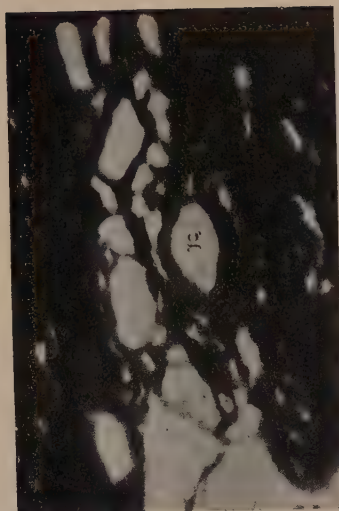
4







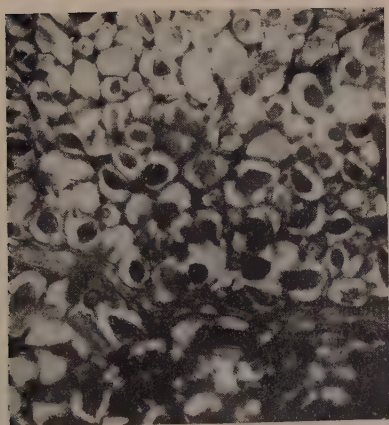
5



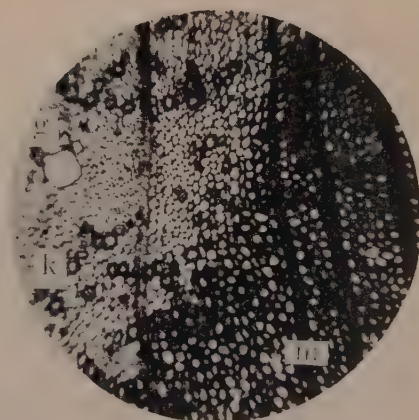
7



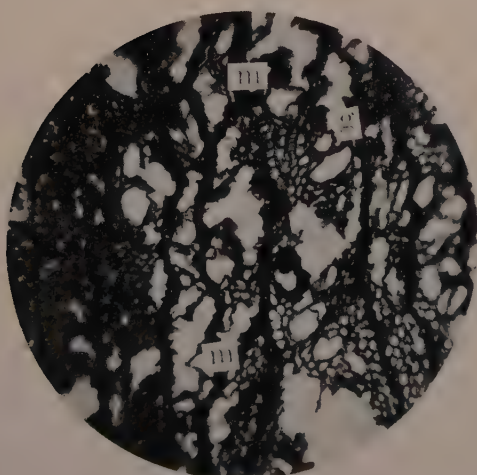
8



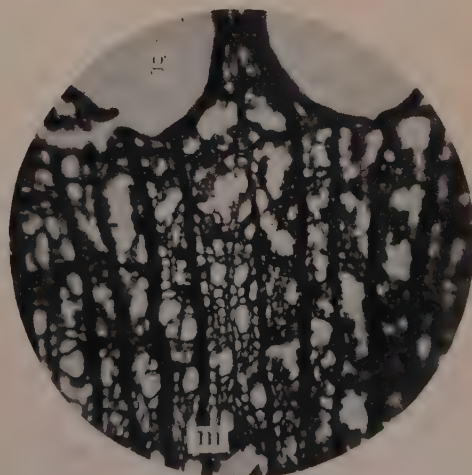
6



9



10



11



# Weitere Untersuchungen über die pentaploiden *Triticum*-Bastarde III<sup>(1)</sup>

Von Hitoshi KIHARA, Shunjiro WAKAKUWA  
und Yukio YAMAMOTO

---

Hierzu zwei Abbildungen im Texte

---

(Eingegangen am 19. Januar 1933)

## Einleitung

In der letzten Mitteilung (1932) dieser Serie ist die Ansicht von WATKINS (1925), der die Sterilität der pentaploiden Weizenbastarde auf das Ausbleiben der Befruchtung in funktionsfähigen Embryosäcken zurückführt, auf breiter experimenteller Basis geprüft worden. Zwei umfangreiche und mit grosser Sorgfalt ausgeführte Versuche ergaben, dass tatsächlich diesem Faktor die Hauptbedeutung zuzuschreiben ist. Zygotenelimination ist aber auch nachgewiesen worden, deren Grad je nach den klimatischen Bedingungen wechselte. Während sie in Sapporo, wo die Verbindung *T. spelta* × *T. polonicum* bedeutend weniger fertil ist als in Kyoto, eine nicht zu unterschätzende Rolle spielte (in ca. 24% der mikroskopisch untersuchten Embryosäcke war der Embryo degeneriert), war sie in Kyoto bei einer 34-chr.<sup>(2)</sup> Pflanze (mit der Chromosomenkombination 14<sub>II</sub>+6<sub>I</sub>) aus derselben Verbindung nur ganz unbedeutend (ca. 5%).

Ausserdem ist in der II. Mitteilung versucht worden, auf Grund der bis damals bekannt gewordenen Versuchsergebnisse über zwei für die Karyogenetik der pentaploiden Bastarde wichtige Punkte nähere Aufklärung zu gewinnen. Diese sind: 1. Konkurrenz der verschiedenen chr. Pollenkörner und 2. unerwartet häufiges Auftreten von 28- und 35-chr. Individuen in manchen Aequationskreuzungen mit Emmer

---

(1) Contributions from the Laboratory of Genetics, Kyoto Imperial University. No. 32.

(2) chr. = Abkürzung für chromosomig.

als Vater. Eine ausführliche Erörterung der beiden Fragen zeigte, dass der Verteilungsmechanismus der 7 Univalenten bei den  $F_1$ -Bastarden einer eingehenderen Untersuchung bedarf. Bis auf weiteres musste die Frage offen gelassen bleiben, ob die Verteilung ausschliesslich vom Zufall abhängt (WATKINS 1930); es erschien möglich, dass die Univalenten eine Neigung haben, zusammenzubleiben, woraus sich ein gruppenweise gebundener Transport dieser Elemente nach den Polen ergeben würde.

Ueber diesen nun wichtig gewordenen Punkt ist inzwischen eine neue Mitteilung von THOMPSON und ARMSTRONG (1932) erschienen, die auf Grund von Zählungen der Chromosomen bei der ersten Kernteilung in jungen Pollenkörnern festgestellt haben, dass die 7 überschüssigen Chromosomen sich (unter mässiger Elimination) dem Zufall nach auf die beiden Pole verteilen. Es soll aber die Entwicklung der Pollenkörner mit intermediären Chromosomenzahlen sich viel langsamer vollziehen und ihre erste Mitose viel später einsetzen als in den 14- und 21-chromosomigen.

Aehnliches haben KIHARA und KATAYAMA (1932) bei haploidem *T. monococcum* beobachtet. In diesem Fall verteilten sich in der I. Anaphase die 7 Univalenten, aus denen die somatische Chromosomengarnitur dieser haploiden Pflanze besteht, meistens ohne Längsteilung und ohne Elimination, dem Zufall nach auf die beiden Pole, in Uebereinstimmung mit der Binomialformel  $(0,5+0,5)^7$ .

Auf Grund dieser Befunde sollte man eigentlich erwarten, dass die Häufigkeit der verschiedenchr. Gonen der pentaploiden Bastarde ungefähr den theoretischen Zahlen der Tab. 1 (2. und 3. Zahlenreihe) entspricht, die aus den Formeln  $(0,6+0,4)^7$  bzw.  $(0,7+0,3)^7$  (bei mässiger bzw. stärkerer Univalentenelimination) gewonnen wurden. Der Nachweis für die ♂ Gonen, ob und inwiefern die tatsächlichen Verhältnisse den theoretischen Zahlen nahe kommen, kann auf Grund der Kreuzungsversuche Eltern  $\times F_1$  nicht erbracht werden, angesichts der starken und komplizierten Konkurrenzwirkung zwischen verschiedenchr. Pollenkörnern. Es ist aber möglich, aus diesen Versuchen das Zahlenverhältnis der 14- und der 21-chr. Pollenkörner zu bestimmen, da das Konkurrenzverhältnis zwischen diesen ziemlich klar ist (KIHARA 1932).

Die Häufigkeit der verschiedenchr. Embryosäcke, die fast alle funktionsfähig sind, ist experimentell nur durch die Aequationskreuzung, also nur auf indirektem Wege, feststellbar. Hier stossen wir aber auch auf eine Schwierigkeit, die in der selektiven Befruch-



tung der 14- und 21-chr. Eizellen besteht. Deshalb hat KIHARA (1932) in der II. Mitteilung betont, dass man in der Zukunft, besonders bei Aequationskreuzungen, auf guten Ansatz und Keimung achten müsse. Durch inzwischen gemachte Erfahrungen sind wir aber zu der Ueberzeugung gekommen, dass auch Resultate mit unvollständigem Ansatz, wenigstens für die Bestimmung des Zahlenverhältnisses der 14- und der 21-chr. Gonen, benutzt werden können.

In folgendem wollen wir daher versuchen, aus den uns nun zur Verfügung stehenden Resultaten von umfangreichen Aequations- und Zertationskreuzungen die Frequenz der 14- und 21-chr. ♀ und ♂ Gonen zu berechnen und die auf diese Weise gewonnenen Zahlen mit den theoretischen der Tab. 1 vergleichen.

TABELLE 1. Theoretische Häufigkeit der verschiedenchromosomigen Gonen bei fehlender, mässiger und stärkerer Univalentenelimination.

Chromosomenzahl	14	15	16	17	18	19	20	21
1. $(0.5+0.5)^7$	0.78	5.47	16.41	27.34	27.34	16.41	5.47	0.78
2. $(0.6+0.4)^7$	2.79	13.06	26.12	29.03	14.35	7.74	1.72	0.16
3. $(0.7+0.3)^7$	8.23	24.71	31.77	22.69	9.72	2.50	0.36	0.02

## Material

Die Rückkreuzungseltern lieferten dieselben reinen Linien, die KIHARA schon immer für die Herstellung pentaploider Bastarde benutzt hat. Ausser des alten *vulgare*-Materials (begrannter Sapporo-Weizen) haben wir zum Vergleich eine europäische unbegrannnte Sorte (*T. vulgare* aus Hohenheim) herangezogen. Die beiden Weizen gaben eine fertile  $F_1$  und eine in bezug auf Begrannung im Verhältnis 3:1 aufspaltende  $F_2$ . Die mit ihnen erzeugten pentaploiden Bastarde wiesen die gleichen Chromosomenverhältnisse auf.

Die ausgeführten Aequations- und Zertationskreuzungen finden sich in Tab. 2 zusammengestellt. Aus dieser kann man sich über die Anzahl der bestäubten Blüten sowie über die Ansatz- und Keimungsverhältnisse orientieren. Die letzte Spalte der Tabelle (Erfolg) gibt den tatsächlich erzielten Kreuzungserfolg an, der aus dem Produkt:  $\text{Ansatz}(\%) \times \text{Keimung}(\%)$  berechnet ist. Der Körneransatz war, wie wir sehen, in allen Fällen unvollständig. Versuche mit vollem Ansatz sind bei uns im Gange.

Die in beiden Versuchsreihen erhaltenen Rückkreuzungsbastarde haben wir, soweit es ging, karyologisch untersucht.

TABELLE 2.

Uebersicht über die ausgeführten reziproken Rückkreuzungen der pentaploiden Bastarde zum hexaploiden und tetraploiden Elter.

## A) Äquationskreuzungen

Kreuzung	Zahl der bestäubten Blüten	Zahl d. Körner (%)	Ausgesät	Gekeimt (%)	Erfolg (%)
$F_1^* \times spelta$	252	120 (47.6)	120	48 (40.0)	19.0
$F_1^* \times polonicum$	276	64 (23.2)	64	41 (64.1)	14.9
$F_1^\dagger \times vulgare$	370	191 (51.6)	190	65 (34.2)	17.7
$F_1^\dagger \times durum$	492	254 (51.6)	253	187 (73.9)	38.2

## B) Zertationskreuzungen

$T. spelta \times F_1^*$	200	65 (32.5)	65	42 (64.6)	21.0
$T. polonicum \times F_1^*$	200	39 (18.5)	39	21 (53.8)	10.5
$T. vulgare \times F_1^\dagger$	180	70 (38.8)	70	63 (90.0)	35.0
$T. durum \times F_1^\dagger$	222	107 (48.2)	107	54 (50.5)	24.3

\*  $T. polonicum \times spelta$ .    †  $T. vulgare \times durum$ .

## Aequationskreuzungen

Die Resultate unserer karyologischen Untersuchungen an diesen Rückkreuzungsbastarden bringt Tab. 3. In Abb. 1 sind sie graphisch dargestellt. Ueber Rückkreuzungen zum hexaploiden Elter finden sich in der Literatur Angaben von WATKINS (1927) und THOMPSON u. CAMERON (1928). Da die diesen zugrunde liegenden Einzelversuche nur kleine Zahlen umfassen, kann hier von ihrer näheren Diskussion abgesehen werden. Die Befunde scheinen, wenigstens zum Teil, mit unseren Resultaten übereinzustimmen.

TABELLE 3. Häufigkeit der in Aequationskreuzungen gefundenen verschiedenchr. ♀ Gonon.

Chromosomenzahl	14	15	16	17	18	19	20	21	Summe
$F_1 \times spelta$	2	0	1	5	13	<b>16</b>	4	1	42
$F_1 \times polonicum$		2	<b>12</b>	8	3	3	0	2	37
$F_1 \times vulgare$	4	3	2	6	<b>9</b>	5	2	0	31
$F_1 \times durum$	<b>37</b>	16	15	4	1	3	1	4	81

Aus der Tabelle geht ohne weiteres hervor, dass sich die Resultate mit hexaploidem Vater ganz anders gestalten als mit tetraploidem. Der Unterschied ist in beiden Versuchen, mit *spelta*- und *polonicum*- bzw. *vulgare*- und *durum*-Pollenträgern, gleichsinnig und recht deutlich<sup>(1)</sup>. Bei der Verbindung  $F_1 \times spelta$  liegt die Mode bei 19, bei  $F_1 \times polonicum$  bei 16. Im zweiten Versuch ist bei der Verbindung mit *durum* die hohe Frequenz der 14-chr. Gonen noch auffälliger. Besonders anschaulich bringt den Unterschied die graphische Darstellung (Abb. 1) zum Ausdruck, in der die Resultate mit den beiden tetraploiden (*T. polonicum* und *durum*) und den beiden hexaploiden Weizen (*T. spelta* und *vulgare*) gemeinsam behandelt sind, als  $F_1 \times$  Emmer bzw.  $F_1 \times$  Dinkel.

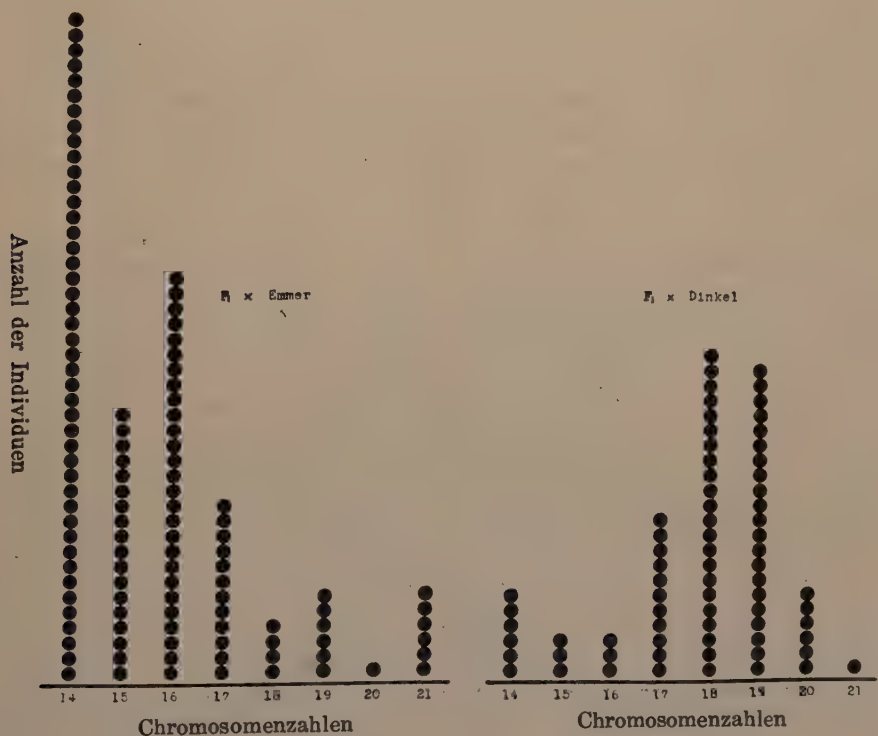


Abb. 1

(1) Die Ursache für die Unterschiede im einzelnen zwischen den beiden Versuchsreihen ist darin zu suchen, dass die Elimination der Univalenten sich bei den Verbindungen *polonicum*  $\times$  *spelta* und *vulgare*  $\times$  *durum* verschieden gestaltet. Sie sollen auch bei der nächsten Gelegenheit, sobald wir über noch grössere Zahlen verfügen, getrennt behandelt werden.

Es unterliegt also keinem Zweifel, dass bei tetraploidem Vater viele (14–17)-chr. Eizellen und nur wenige (18–21)-chromosomige befruchtet wurden, woraus sich die ausgeprägte Schiefheit der betreffenden Variationsreihe in Abb. 1 ergibt.

Die Frequenzreihen für die Verbindungen mit hexaploidem Vater stehen einer Zufallsverteilung viel näher. Eine leichte Schiefheit macht sich aber auch hier bemerkbar, und zwar auf der rechten Seite. Sie könnte so gedeutet werden, dass in diesem Fall die (18–21)-chr. Embryosäcke aktiver sind als die mit den niedrigen Chromosomenzahlen. Man darf aber nicht vergessen, dass die Keimung der Körner der tetraploid  $\times$  hexaploid-Verbindungen mangelhaft ist; die relativ geringe Frequenz auf der linken Seite wäre danach wenigstens zum Teil auf die unvollständige Keimung der Kombinationen (15–17)-chr. Eizellen  $\times$  21-chr. Spermakerne zurückzuführen.

Aus diesen Ergebnissen folgt, dass die Annahme einer besonderen Aktivität der euploiden Embryosäcke, vor allem der 14-chromosomigen, sich nicht umgehen lässt. Wäre eine solche nicht vorhanden, dann müsste sich die Zahlenverteilung in den oben besprochenen Versuchen ähnlich gestalten, unabhängig von der Chromosomenzahl des Vaters.

Es sei noch auf die auffallende Flachheit der Frequenzreihen hingewiesen, die zum Teil mit der Elimination der ♀ Gonen mit intermediären Chromosomenzahlen zusammenhängen dürfte.

### Zertationskreuzungen

Ueber diese Versuche orientiert Tab. 4. Eine graphische Darstellung der in der Tabelle gegebenen Zahlenreihen bringt Abb. 2; auch hier sind die Versuche mit den beiden tetraploiden Weizen (*T.*

TABELLE 4. Häufigkeit der in Zertationskreuzungen gefundenen verschiedenchr. ♂ Gonen.

Chromosomenzahl	14	15	16	17	18	19	20	21	Summe
<i>T. spelta</i> $\times$ $F_1$	8	2	3	0	2	2	6	11	34
<i>T. polonicum</i> $\times$ $F_1$	9	4	0	2	2	0	1	0	18
<i>T. vulgare</i> $\times$ $F_1$	6	7	2	2	4	2	1	8	32
<i>T. durum</i> $\times$ $F_1$	12	8	2	0	1	0	0	0	23



*polonicum* und *durum*) und die mit den hexaploiden (*T. spelta* und *vulgare*) als Mutter zusammengefasst. Die sich für die Verbindungen hexaploid  $\times F_1$  ergebenden Frequenzreihen sind ausgesprochen U-förmig, während die für tetraploid  $\times F_1$  die gleiche Schiefeit zeigen wie die reziproken Aequationskreuzungen (Abb. 2). Es ist also das Zahlenverhältnis zwischen den 14- und den 21-

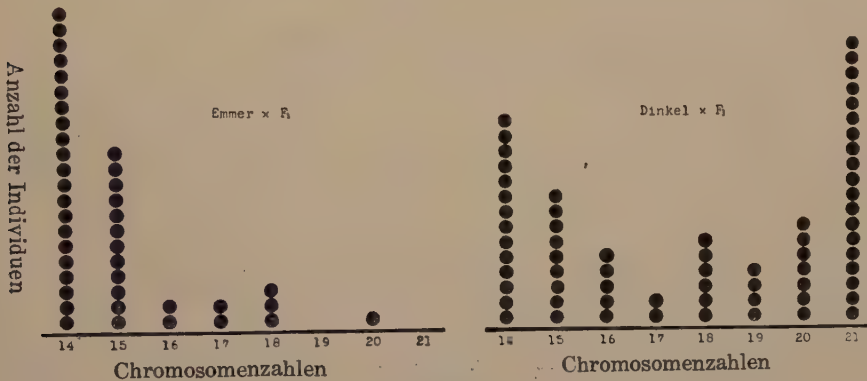


Abb. 2

chr. Pollenkörnern bei tetraploiden und hexaploiden Weizen als Mutter sehr verschieden. Im ersten Fall sind in unserem Versuch sogar ausschliesslich 14-chr. Spermakerne zur Befruchtung gekommen. Bei hexaploid  $\times F_1$  sind die durch die Befruchtung mit 21-chr. Spermakernen erzeugten Individuen etwas zahlreicher vertreten als die durch 14-chromosomige. Die Konkurrenzversuche mit gemischtem Pollen (*vulgare*  $\times$  / *durum* + *vulgare* /) haben gezeigt, dass auf 10 mit *vulgare*-Pollin befruchtete *vulgare*-Eizellen eine mit *durum* befruchtete entfällt. Für das obige Resultat muss also der  $F_1$ -Pollin ungefähr 7 mal so viel 14-chr. Pollenkörner enthalten haben als 21-chromosomige (vgl. S. 419).

Wie stark die Konkurrenz zwischen euploiden (14- und 21-chr.) und aneuploiden (/15-20/-chr.) Pollenkörnern ist, zeigt zur Genüge die J-bzw. U-Gestalt der Frequenzreihen (Abb. 2). Ohne Konkurrenz wäre eine leicht schiefe binomiale Verteilung zu erwarten gewesen.

## Diskussion

Im vorhergehenden haben wir auf Grund unserer Versuche mit Aequations- und Zertationskreuzungen eine Orientierung über die

Frequenz der verschiedenchr. ♀ und ♂ Gonen der pentaploiden  $F_1$ -Bastarde gegeben, die an dem Zustandekommen der Chromosomenkombinationen in  $F_2$  teilnehmen.

Nun wollen wir nur die euploiden Gonen in Betracht ziehen und versuchen, die Verhältniszahlen für 14- und 21-chr. Embryosäcke und Pollenkörner näher zu bestimmen.

Zuerst wollen wir das Verhältnis der ♀ 14- und 21-chr. Gonen aus den Aequationskreuzungen wie folgt ableiten.

In der Aequationsverbindung  $F_1 \times$  Dinkel haben wir aus der Befruchtung von 14-chr. bzw. 21-chr. Eizellen 6 bzw. 1 Nachkommen erhalten. Die entsprechenden Zahlen im Versuch  $F_1 \times$  Emmer waren 44 bzw. 6 (vgl. Tab. 3). Aus der Summierung dieser Zahlen ergeben sich 50 14- und 7 21-chr. Eizellen. Danach wäre das Verhältnis 7:1.

Es muss aber einerseits berücksichtigt werden, dass in der Kreuzung  $F_1 \times$  Emmer die Kombination 14-chr.+14-chr. leichter zustande kommt als die Kombination 21-chr.+14-chr. Es müssen also auf 44 14-chr. Eizellen etwas mehr als 6 21-chr. vorhanden gewesen sein. Ihre Anzahl lässt sich leicht an Hand des von WAKAKUWA (WAKAKUWA 1930, KIHARA 1932) festgestellten Prozentsatzes angesetzter Körner bestimmen, der bei der Kreuzung Dinkel  $\times$  Dinkel rund 100%, bei Dinkel  $\times$  Emmer nur rund 75% betrug. Auf Grund dieses Befundes können wir die Zahl 6 auf 8 korrigieren. Andererseits wiederum muss in Betracht gezogen werden, dass im Versuch  $F_1 \times$  Dinkel nur ein Teil der gebildeten 35-chr. Zygoten zur Entwicklung gelangt ist, da die Körner mit pentaploidem Embryo und heptaploidem Endosperm nur zu 60% keimfähig sind (WAKAKUWA 1930). Danach müssen wir für diese Verbindung nicht 6, sondern 10 14-chr. Eizellen gegen 1 21-chr. annehmen. Wenn wir diese Korrekturen für die beiden Aequationskreuzungen ausführen, ergibt sich für die 14- und die 21-chr. Embryosäcke das Verhältnis ca. 6:1 ( $(10+44):8+1$ ).

Wenden wir uns nun der Bestimmung des Zahlenverhältnisses der euploiden ♂ Gonen zu. Auf Grund der Voraussetzung, dass bei der Zertationskreuzung Dinkel  $\times F_1$  21-chr. Pollenschläuche in zehnfachem Vorteil gegen die 14-chromosomigen sind, können wir bei dieser Verbindung die beiden Pollensorten im Verhältnis 1:1 nur dann erwarten, wenn im  $F_1$ -Pollen die 14- und die 21-chr. Körner im Verhältnis 10:1 gemischt vorkommen. Aus Tab. 4 ist aber zu entnehmen, dass von 34 euploiden Pollenschläuchen 14 14- und 19 21-chromosomige die Befruchtung ausgeführt haben. Wenn wir die Anzahl der 14-chromosomigen Pollenkörner der obigen Vorausset-

zung entsprechend mit 10 multiplizieren, ergibt sich für die beiderlei euploiden ♂ Gonen das Verhältnis 7,3:1 ( $14 \times 10:19$ ). Auf die Berechnung des Verhältnisses auf Grund der Zertationskreuzung Emmer  $\times F_1$  müssen wir verzichten, da in diesem Versuch keine einzige Befruchtung mit einem 21-chr. Pollenschlauch ein entwicklungsfähiges Korn ergeben hatte. An diesem Resultat ist die zu geringe Anzahl der untersuchten  $F_2$ -Individuen schuld (vgl. KIHARA 1932). Man muss hier nämlich berücksichtigen, dass die Körner mit pentaploidem Embryo, wie oben erwähnt, nur zu 60% keimfähig sind, wodurch die Anzahl 35-chr. Individuen in  $F_2$  stark heruntergesetzt wird und das auf Grund der Zertationskreuzung Dinkel  $\times F_1$  erwartete Verhältnis 7:1 nicht realisiert werden kann. Wir haben versucht, die Resultate anderer Autoren über die Zertationskreuzungen mit tetraploider Mutter heranzuziehen (sie finden sich in der II. Mitteilung in Tab. 13 aufgeführt) und mit unseren zusammenzustellen. Aus dieser Berechnung ergaben sich gegen 97 14-chr. Pollenkörner 13 21-chromosomige, was ja dem Verhältnis 7:1 ungefähr entspricht. Dieses Resultat könnte aber auch ein zufälliges sein, durch die heterogene Beschaffenheit des der Berechnung zugrunde gelegten Materials bedingt, da die Einzelversuche mit verschiedenen Sorten und verschiedenen Methoden ausgeführt waren. Ein Blick auf die Tab. 13 in der II. Mitteilung legt diese Annahme sehr nahe.

Unsere Ueberlegungen über das Verhältnis der 14- und 21-chr. Gonen beim  $F_1$ -Bastard führen danach zu dem bemerkenswerten Befund, dass es für beide Geschlechter ungefähr dasselbe ist (für ♀ Gonen ca. 6:1, für ♂ ca. 7:1).

Es fragt sich nun, welchen Prozentsatz der gesamten Gonen stellen die beiderlei euploiden Embryosäcke und Pollenkörner dar. Im Aequationsversuch  $F_1 \times durum$  (Tab. 1 und 3) sind 492 Blütchen bestäubt worden; von 81 untersuchten Individuen waren 37 tetraploid. Es müssen daher beim  $F_1$ -Bastard mindestens 7,5% der Embryosäcke 14-chr. gewesen sein. Bei der Annahme einer stärkeren Univalentenelimination  $[(0,7+0,3)^7]$  würden sie zwar ungefähr in der nötigen Anzahl gebildet werden, aber die Zahl der 21-chromosomigen darf bei derselben Annahme nur 1/411 der 14-chromosomigen betragen. In Wirklichkeit haben wir aber unter 7 euploiden Embryosäcken einen 21-chromosomigen gefunden, also bedeutend mehr.



Die Frequenz der 14- und 21-chr. Embryosäcke stellt sich noch beträchtlich höher, wenn sie nach der untenstehenden Formel von WATKINS (1930) berechnet wird:

Ansatz%  $\times$  Keimung%  $\times$  Häufigkeit der 28-chr. (35-chr.) Individuen in der Aequationskreuzung ( $F_1 \times durum$ )<sup>(1)</sup>.

Die sich hieraus ergebenden Prozentsätze sind für die beiderlei ♀ Gonen wie folgt:

14-chr. Embryosäcke	$51,6 \times 73,9 \times (37/81 \times 100) = 17,4\%$
21-chr. Embryosäcke	$51,6 \times 73,9 \times (4/81 \times 100) = 1,9\%$

Zur Erklärung des Ueberschusses der 14-chr. ♀ Gonen sind zwei verschiedene Vermutungen ausgesprochen worden. SAX (1928) meint, dass die überschüssigen Dinkelchromosomen im Laufe der Embryoentwicklung eliminiert werden. WATKINS (1930) hingegen ist der Ansicht, dass die Univalenten, wenigstens in den Reifungsteilungen der Embryosackmutterzellen, nicht nach dem Zufall verteilt werden.

Die Annahme von SAX stimmt sehr gut zu dem Ueberschuss der tetraploiden Nachkommen, sie trifft aber nicht die sonderbare Flachheit der Frequenzreihen und den im Zusammenhang mit dieser stehenden Ueberschuss der pentaploiden Individuen. In dieser Beziehung ist der Erklärungsversuch von WATKINS viel einleuchtender. Direkte Untersuchungen der meiotischen Vorgänge in den Embryosackmutterzellen sind vonnöten.

Wie steht es nun mit den ♂ Gonen? Aus den Zertationsversuchen können wir nur entnehmen, dass das Zahlenverhältnis der 14- und der 21-chr. Pollenkörner ungefähr 7:1 ist. THOMPSON und ARMSTRONG (1932) haben 189 Kernplatten im jungen Pollen eines pentaploiden  $F_1$ -Bastards analysiert. Darunter waren 8 (4,2%) 14- und 11 (5,8%) 21-chr. Auch bei den genannten Autoren stellt sich die Verteilung sehr flach dar; es müssen zur Zeit der Untersuchung sehr viele heteroploide und auch viele diploide Pollenkörner sich noch im Ruhezustand befunden haben. Bei zufallsmässiger Verteilung der Univalenten ohne Elimination ( $1/0,5 + 0,5/1$ ) müsste der Prozentsatz der euploiden Pollenkörner 0,78% ausmachen (Tab.1). Ob die Anzahl der im Ruhezustand gebliebenen Pollenkörner gross genug ist, um die flache Kurve so steil wie erwartet zu machen, ist auch eine Frage, die unentschieden bleiben muss. Angesichts des Be-

(1) KIHARA (1932) hat die Formel Ansatz(%)  $\times$  Häufigkeit(%) benutzt.



fundes, dass das Verhältnis der 14- zu den 21-chr. Pollenkörnern ungefähr 7:1 ist, was auf eine merklich schwächere Univalenten-elimination hinweist als die auf Grund direkter Beobachtung gefundene, muss man auch für die Pollenmutterzellen eine von der rein zufallsmässigen abweichende Univalentenverteilung annehmen. Die direkte Beobachtung der Pollenmutterzellen machte den Eindruck, dass die Dinkelchromosomen (abgesehen von der Elimination) nach dem Zufall verteilt würden. Die Vererbungsuntersuchungen zeigen, dass der auf Schätzung beruhende Eindruck nur ungefähr den wirklichen Verhältnissen entsprechen kann. Eine zuverlässige statistische Bearbeitung des mikroskopischen Materials ist mit solchen Schwierigkeiten verbunden, dass sie praktisch kaum durchführbar sein dürfte.

Wir wollen noch versuchen, die verschiedenchromosomigen ♀ und ♂ Gonen in 2 Gruppen einzuteilen, eine mit 14–17, die andere mit 18–21 Chromosomen, und mit diesen auf Grund der Tab. 3 und 4 zu operieren. Die auf diese Weise erhaltenen Resultate sind in Tab. 5 zusammengestellt.

TABELLE 5. Prozentsatz der in Funktion getretenen (14-17)- und (18-21)-chr. ♀ und ♂ Gonen beim pentaploiden  $F_1$ -Bastard (auf Grund von Aequations- und Zertationsversuchen).

Kombination		(14-17)-chr. Gonen (%)	(18-21)-chr. Gonen (%)
Aequations- kreuzung	$F_1 \times polonicum$	78	22
	$F_1 \times spelta$	19	81
	$F_1 \times durum$	89	11
	$F_1 \times vulgare$	48	52
Zertations- kreuzung	$polonicum \times F_1$	83	17
	$spelta \times F_1$	38	62
	$durum \times F_1$	96	4
	$vulgare \times F_1$	53	47

Aus der Tabelle ist auf den ersten Blick ersichtlich, dass die (14–17)-chr. Gameten sich vorzugsweise mit 14-chromosomigen verbinden und die (18–21)-chr. mit 21-chr. Zwischen den beiden Gonen-gruppen tritt eine sehr starke Konkurrenzwirkung in beiden Geschlechtern in Erscheinung. Da die höherchromosomige Gruppe

weniger Vertreter hat als die minderchromosomige, muss die Tüchtigkeit der (18-)21-chr. Gonen ausserordentlich gross sein. Eine derartige selektive Befruchtung ist auch bei der Selbstbestäubung der pentaploiden  $F_1$ -Bastarde anzunehmen. In Tab. 6 sind die sich hierbei ergebenden viererlei möglichen Kombinationen mit  $x_1$ — $x_4$  bezeichnet.

TABELLE 6. Die viererlei Kombinationen, die sich beim  $F_1$ -Bastard aus der Verbindung der verschiedenchr. Gametengruppen ergeben.

$\frac{\text{♀}}{\text{♂}}$	14-17	18-21
14-17	$x_1$	$x_2$
18-21	$x_3$	$x_4$

Bei der Annahme einer selektiven Verbindung im obigen Sinne müssen die Frequenzzahlen für  $x_1$  und  $x_4$  grösser ausfallen als für  $x_2$  und  $x_3$ <sup>(1)</sup>. Aus den Zahlen der Tab. 5 kann man ferner schliessen, dass die Frequenz von  $x_1$  bei dem  $F_1$ -Bastard *T. vulgare*  $\times$  *durum* bedeutend grösser ist als die von  $x_4$ . Das steht in Einklang mit dem Ueberwiegen der Vertreter der Verminderungsgruppe in der Nachkommenschaft dieser Verbindung. Bei der Verbindung *T. spelta*  $\times$  *polonicum* hingegen ist  $x_1$  nicht merklich grösser als  $x_4$ ; in diesem Fall scheint die Tüchtigkeit der (18-)21-chr. Gonen besonders gross zu sein (Tab. 5). In einem kleinen Versuch mit dieser Verbindung hat KIHARA (1924) relativ viel Vertreter der Vermehrungsgruppe gefunden.

Der Unterschied in bezug auf die Häufigkeit der Vertreter der Verminderungs- und der Vermehrungsgruppe bei verschiedenen pentaploiden Verbindungen könnte auf drei Faktoren zurückgeführt werden, nämlich 1. Grad der Abweichung der Univalentenverteilung von einer rein zufallsmässigen, 2. verschiedene Intensität der Univalentenelimination und 3. Gendifferenzen. Dass der unter 2. genannte Faktor eine Rolle spielen kann, geht aus den Beobachtungen von KIHARA (1924, 1931) hervor, der in den PMZ der Verbindung *T. polonicum*  $\times$  *spelta* einen merklich mildereren Univalentenverlust festgestellt hat als bei

(1)  $x_2$  und  $x_3$  repräsentieren die Individuen mit  $\pm 35$  Chromosomen.

*T. durum*  $\times$  *vulgare*. Mit dieser Beobachtung stimmt unser Befund bei den Aequationsverbindungen  $F_1 \times \textit{polonicum}$  und  $\times \textit{durum}$  überein. Bei der ersteren ist das Verhältnis 14-chr.: 21-chr. Gonen im Vergleich mit der letzteren zugunsten der 21-chr. verschoben. Die Untersuchung der  $F_2$ -Nachkommenschaften verschiedener pentaploider Bastarde, die in dieser Hinsicht von grossem Interesse sein dürfte, wird den Hauptgegenstand unserer nächsten Mitteilung in dieser Serie darstellen.

---

## Zitierte Literatur

- KIHARA, H. 1924. Cytologische und genetische Studien bei wichtigen Getreidearten mit besonderer Rücksicht auf das Verhalten der Chromosomen und die Sterilität in den Bastarden. Mem. Coll. Sci. Kyoto Imp. Univ. B. 1.
- 1931. Studies on chromosome-numbers of plants. (Japanisch). Einleitung zu "A list of chromosome-numbers of plants cultivated in Japan" by H. KIHARA, Y. YAMAMOTO and S. HOSONO. Tokyo.
- 1932. Weitere Untersuchungen über die pentaploiden *Triticum*-Bastarde. II. Japan. Journ. Bot. 6.
- KIHARA, H. und KATAYAMA, Y. 1932. Über das Vorkommen von haploiden Pflanzen bei *Triticum monococcum*. (Japanisch). Kwagaku. 2.
- SAX, K. 1928. Chromosome behavior in *Triticum* hybrids. Zeitschr. Ind. Abst. u. Vererb.-Lehre. Supp. 2.
- TOMPSON, W. P. and CAMERON, D. R. 1928. Chromosome numbers in functioning germ cells of species-hybrids in wheat. Genetics, 13.
- THOMPSON, W. T. and ARMSTRONG, J. M. 1932. Studies on the failure of hybrid germ cells to function in wheat species crosses. Canadian Journ. Research. 6.
- WAKAKUWA, SH. 1930. Bestäubungs- und Keimungsversuche in reziproken *Triticum*-Kreuzungen. Japanese Journ. Gen. 6.
- WATKINS, A. E. 1925. Genetic and cytological studies in wheat. II. Journ. Gen. 15.
- 1927. Idem. III. Ibid. 18.
- 1930. The wheat species: a critique. Ibid. 23.
-



# Karyologische und genetische Studien an *Fragaria* I

## Ein tetraploider fertiler Bastard zwischen *F. nipponica* ( $n=7$ ) und *F. elatior* ( $n=21$ )<sup>(1)</sup>

Von F. A. LILIENFELD

---

Hierzu 37 Abbildungen im Text

---

(Eingegangen am 20. Januar 1933)

### Einleitung

Es ist verschiedentlich versucht worden, Bastarde zwischen diploiden Arten von *Fragaria* und der einzigen hexaploiden Art, *F. elatior*, herzustellen. Sämtliche bisherigen Versuche sind aber so gut wie ergebnislos verlaufen. MANGELSDORF und EAST (1927) und YARNELL (1931a) berichten, dass diploide Arten mit *elatior*-Pollen bestäubt zwar leicht und reichlich ansetzen, aber fast ausschliesslich keimunfähige Nüsschen geben. So haben bei MANGELSDORF und EAST von ca. 600 Nüsschen nur 4 gekeimt; die Keimlinge waren sehr schwächlich und gingen vor der Entfaltung des ersten Laubblattes ein. YARNELL hat aus ca. 800 Nüsschen keinen einzigen Bastardsämling bekommen; einzelne Pflanzen, die er in manchen Kreuzungen erhielt, waren der Mutter gleich und wie diese diploid (ICHIJIMA 1930). Die reziproke Verbindung mit *F. elatior* als Mutter gab zum grössten Teil gar keinen Ansatz. Einzelne keimfähige Nüsschen in YARNELLS Versuchen entwickelten sich zu mütterlichen Individuen, die alle nach ICHIJIMA (1930) hexaploid waren. Auch CORRENS (1928) berichtet, dass ihm von allen Bastardierungen, die er mit *F. elatior* versucht hat, nur eine gelungen ist, nämlich die mit *F. grandiflora* als Mutter.

Der von mir im J. 1931 unternommene Kreuzungsversuch zwischen der diploiden *F. nipponica* MAKINO und *F. elatior* hat von den oben angeführten sehr abweichende Resultate ergeben, worüber in folgendem berichtet wird.

---

(1) Contributions from the Laboratory of Genetics, Kyoto Imperial University. No. 33.

## Material und Methoden

Die diploide Art gab in meinen Versuchen, wie oben erwähnt, *F. nipponica* MAKINO ab, die von den japanischen Systematikern zur *vesca*-Gruppe gestellt wird. Das Material hat einer unserer Mitarbeiter, Herr Dr. S. HOSONO, im Winter 1931 auf dem Berge Fuji gesammelt und mir zur Verfügung gestellt, wofür ich ihm bestens danke. Die Pflanzen blühten in Kyoto recht spärlich, besonders im ersten Jahre (Frühjahr 1931); die sich zuerst öffnenden Blüten waren oft weiblich, die folgenden erst morphologisch vollzwittrig. Im zweiten Jahre habe ich erste weibliche Blüten nur ausnahmsweise beobachtet. Auf ihrem natürlichen Standort soll die Pflanze sehr reich blühen und fruchten. Meine Beobachtungen über ihre Fertilität bei Selbstung in Kyoto sind vorläufig nicht zahlreich, da ich die spärlich blühenden Stöcke vor allem zu Kreuzungen bzw. Rückkreuzungen gebraucht habe; sie haben sich dabei alle auf ♀ und ♂ Seite als gut fertil erwiesen. Alle künstlichen Selbstbestäubungen an isolierten Pflanzen versagten hingegen im ersten Jahre gänzlich. Daraufhin habe ich versucht, Ansatz aus Bestäubungen zwischen zwei verschiedenen Stöcken zu erhalten. Gleich der erste Versuch glückte und ergab eine Frucht mit gutem Ansatz und normale Sämlinge. Im zweiten Jahre konnte ich bei Selbstbestäubung eine Frucht mit 6 guten Nüsschen ernten. Aus diesen erhielt ich 3 sehr schwächliche Zwergpflanzen.

Abb. 20 bringt ein Blatt von *F. nipponica*. Die langgestielten Blätter haben sehr charakteristische Gestalt und Randzählung. Die Pflanze sieht sehr zart aus und bildet zahlreiche Ausläufer. Sie scheint in Kyoto nicht besonders gut zu gedeihen.

Das Material von *F. elatior* stammt aus den bekannten Geschlechtsversuchen von CORRENS und ist im Winter 1930 von Herrn Prof. Dr. H. KIHARA aus Berlin mitgebracht worden. Die Pflanzen haben sich in Kyoto sehr kräftig entwickelt und blühten reichlich. Die Blattgestalt ist aus Abb. 19 zu ersehen.

Bei den Bestäubungen sind keine anderen Vorsichtsmassregeln getroffen worden als die bei Versuchen mit Insektenbestäubern üblichen. Die eingetopften Pflanzen waren in einem Gewächshaus untergebracht, in Kästen aus Drahtgaze. Um Besuch von Ameisen und anderen kriechenden Insekten zu vermeiden, ist jeder Topf auf einer passenden Erhöhung in die Mitte einer mit Wasser gefüllten

Schale gestellt worden. Trotz dieser einfachen Versuchsanordnung ist mir bis jetzt keine einzige Fehlbestäubung begegnet. Ich habe sogar bemerkt, dass unbestäubt gelassene Blüten an ♀ Versuchstöcken von *F. elatior* ohne Ansatz blieben, trotzdem die Pollenträger (auch dann, wenn es ♂ *elatior*-Stöcke waren) in ihrer Nähe im gleichen Käfig standen. Die einzige, allerdings sehr wichtige Fehlerquelle, die bis jetzt bei mir in Betracht kommt, liegt in der Vermischung bzw. Verwechslung durch Ausläufer.

Ich glaube beobachtet zu haben, dass, wenigstens unter den Versuchsbedingungen in Kyoto, die Empfängnisfähigkeit der Narben nur kurz dauert, und dass der frische Zustand des Pollens von grosser Wichtigkeit ist. Deshalb habe ich jede sich öffnende Blüte 3–4 Tage hintereinander mit dem für sie bestimmten, immer frischen Pollen reichlich belegt. Auf diese Weise habe ich in der Regel Ansatz erzielt, während einmalige Bestäubungen oft teilweise oder auch ganz versagten.

Die Aussaat fand unmittelbar nach der Ernte statt, und zwar auf sterilem Sand, auf dem die vom Fruchtfleisch gereinigten Nüsschen ausgelegt wurden. Sie wurden nicht zugedeckt, so dass die Keimung im Lichte erfolgte. Nach der Entfaltung der Cotyledonen sind die Pflänzchen in Kisten mit steriler Erde auspikiert worden. Nach einigen Wochen hat man sie dann einzeln eingetopft. Leider haben sich die Bedingungen in Kyoto in den heissen und zugleich feuchten Sommermonaten als sehr ungünstig für die Aufzucht der Keimlinge erwiesen. Während die Schwierigkeiten im Sommer 1931 durch besonders sorgfältige Pflege der Pflänzchen überwunden werden konnten, liessen sich beträchtliche Verluste im Sommer 1932, der ungewöhnlich heiss war, nicht verhüten. Viele der auspikierten Keimlinge gingen in den Kisten ein; einen weiteren Teil habe ich später, nachdem die eingetopften Pflanzen ins Freiland herausgestellt worden waren, eingebüsst. Von insgesamt 1166 pikierten Keimlingen waren im Herbst 1932 nur noch 781 am Leben (ca. 67%). Es handelte sich aber dabei im allgemeinen nicht etwa um eine Ausmerzung von lebensunfähigeren Typen. Die Verluste hatten zufälligen Charakter, da die Pflänzchen gruppenweise bzw. kistenweise eingingen. Derselbe Schluss musste auch aus dem Vergleich von zufällig mehr oder weniger vollständig erhaltenen Nummern mit den schwer geschädigten gezogen werden. Den Winter 1931 haben sowohl die  $F_1$ -Sämlinge als auch die Selbstungen gut überstanden.

Die Chromosomen sind in Wurzelspitzen und in Pollenmutterzellen untersucht worden. Die ersteren wurden mit NAWASCHIN, die letzteren mit CARNOY fixiert. Gefärbt wurde mit HEIDENHAINS Haematoxylin.

## Kreuzungsversuche

### F<sub>1</sub>-Generation

#### *F. elatior* ♀ × *F. nipponica* ♂

Diese Verbindung, im Frühjahr 1931 ausgeführt, gelang sehr leicht. Von 189 Nüsschen, unter denen sich grössere plumpe und kleinere schlanke unterscheiden liessen<sup>(1)</sup>, keimten 50. Von den 50 Keimlingen sind im Laufe des Sommers 6 eingegangen, so dass die F<sub>1</sub> im Herbst 1931 aus 44 kräftigen Individuen bestand.

Diese F<sub>1</sub> stellte sich, besonders in bezug auf Wüchsigkeit, sehr einheitlich dar. Das *elatior*-Elter dominierte im Allgemeineindruck so stark, dass man sie ohne weiteres für einen *elatior*-Bestand hätte halten können. Bei direktem Vergleich mit einer gleichzeitig unter denselben Bedingungen aus Samen gezogenen *elatior*-Nachkommen-schaft (vgl. Tab. 2, S. 434) konnte man im Herbst 1931 nur einen Unterschied in Wüchsigkeit feststellen: die F<sub>1</sub> stellte sich weniger kräftig dar. Dieser Unterschied war bei den vollentwickelten Pflanzen im Sommer 1932 viel deutlicher. Blattform und Randzählung variierten hier und dort in ähnlicher Weise. In Abb. 21 ist ein Blatt aus der F<sub>1</sub> zu sehen.

Die Zählung der somatischen Chromosomen in Wurzelspitzen bei einer Reihe der F<sub>1</sub>-Individuen ergab, dass es sich um echte Bastarde handelte. In jedem der untersuchten Fälle konnte die Zahl 28 einwandfrei festgestellt werden. Abb. 1, 2 und 4 zeigen die somatischen Chromosomen der Eltern (Abb. 1 und 4<sup>2)</sup>) und des Bastards (Abb. 2).

Von den 44 F<sub>1</sub>-Pflanzen haben im Sommer 1932 13 (29,5%) geblüht; von 87 *elatior*-Sämlingen blühten gleichzeitig 33 (37,9%). Die F<sub>1</sub>-Pflanzen waren, ebenso wie die *elatior*-Sämlinge, getrenntgeschlechtlich; 6 waren weiblich, 7 männlich<sup>3)</sup>. Die Antheren sahen gut

(1) Die kleinen schlanken Nüsschen haben sich später nur ganz ausnahmsweise als keimfähig erwiesen.

(2) Abb. 4 ist von Prof. KIHARA gezeichnet.

(3) Bis jetzt (Mai, 1933) haben insgesamt 34 F<sub>1</sub>-Pflanzen geblüht, darunter 14 ♀ und 20 ♂. Von den *elatior*-Sämlingen blühten gleichzeitig 65, und zwar 29 ♀ und 36 ♂ (Zusatz bei der Korrektur).



aus, platzten auf und entleerten viel guten gelben Pollen. Wie Abb. 16 und 17 zeigen, stellte sich der Pollen im mikroskopischen Bild ungefähr so dar wie der von *F. elatior*, vielleicht sogar etwas besser.

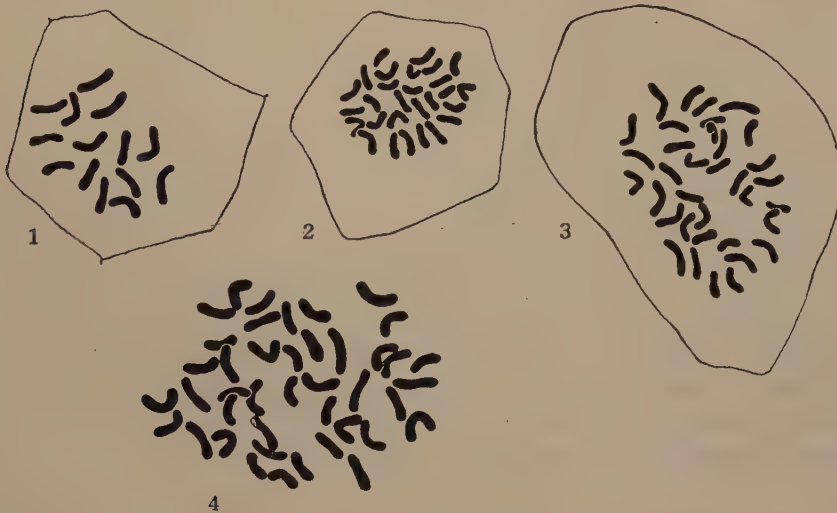


Abb. 1-4. Somatische Chromosomen aus Wurzelspitzen. Abb. 1. *F. nipponica*; 14 Chromosomen. Abb. 2.  $F_1$ -Bastard *F. elatior* ♀ × *F. nipponica* ♂; 28 Chromosomen. Abb. 3.  $F_1$ -Bastard *F. nipponica* ♀ × *F. elatior* ♂; 35 Chromosomen. Abb. 4. *F. elatior*; 42 Chromosomen. Abb. 1-3 ca. 2530fach, Abb. 4 ca. 3600fach vergrößert.

Wie daraus zu erwarten, waren auch die Weibchen fertil und setzten bei Bestäubungen mit dem Pollen der Männchen gut an. Die Früchte waren wahrscheinlich kleiner als die der *elatior*-Sämlinge. Bei den im Gewächshaus ausreifenden Früchten war dieser Unterschied kaum merklich; für einen zuverlässigen Vergleich im Freien fehlte mir das Material, da die 6  $F_1$ -Weibchen vor allem zu Versuchszwecken herangezogen wurden. Die gute Fertilität erhöhte noch die Aehnlichkeit der  $F_1$  mit dem *elatior*-Elter. In bezug auf die Gestalt der Frucht und die Lage (eingesenkte oder oberflächliche) der Nüsschen war eine deutliche Aufspaltung zu sehen. Aehnliches konnte man auch bei den *elatior*- und den *nipponica*-Sämlingen beobachten.

Die Reifungsteilungen der P.M.Z. boten, den Fertilitätsverhältnissen entsprechend, ein sehr regelmässiges Bild. Es treten in der I. Metaphase in der Regel 14 Bivalente auf, die sich in jeder günstigen Polansicht leicht zählen lassen (Abb. 5), während eine sichere Fest-

stellung der Chromosomenzahlen in Seitenansichten sehr schwer ist. Geschlossene tetravalente Verbände aus zwei gleich grossen Chromosomenpaaren mit Ring- (Abb. 7) oder Zickzackanordnung (Abb. 6) der Glieder kommen nicht selten vor. Ihre Häufigkeit pro P.M.Z. liess sich leider nicht feststellen, da die Verbindung der sehr kleinen Chromosomen zu Komplexen meistens nur in Seitenansichten deutlich ist, wo eine eingehende Analyse der dicht zusammengedrängten Äquatorialplatte grosse Schwierigkeiten bereitet. Wenn sich, wie in Abb. 7, ein Komplex deutlich von der Platte abhebt, dann ist es meistens unmöglich ganz sicher zu sagen, ob nicht noch mehr von den übrigen Paaren Verbände bilden. In Polansichten wiederum, die leicht analysierbar sind, sieht man zwar oft zwei dicht beieinander liegende Paare, es lässt sich aber nur ausnahmsweise mit Sicherheit entscheiden, ob eine Verbindung zwischen ihnen besteht. Vorläufig steht es nur fest, dass in einer P.M.Z. zwei tetravalente Komplexe vorkommen können, einer aus grösseren, der andere aus merklich kleineren Einheiten. Als höchste Zahl glaube ich 3 Tetravalente in einer Zelle beobachtet zu haben.



Abb. 5-10.— $F_1$ -Bastard *F. elatior* ♀ × *F. nipponica* ♂. I. Reifungsteilung in P.M.Z. Vergr. ca. 2530fach.

Abb. 5. I. Metaphase, Polansicht; 14II.

Abb. 6. I. Metaphase, Polansicht; 12II+1IV. Der geschlossene tetravalente Komplex ist zickzackförmig.

Abb. 7. I. Metaphase, Seitenansicht. Ein ringförmiger tetravalenter Komplex.

Abb. 8. I. Metaphase, Seitenansicht; 2 Univalente in seitlicher Lage (in bezug auf die Äquatorialplatte).

Abb. 9. I. Anaphase, Seitenansicht. Keine verzögerten Chromosomen.

Abb. 10. Anaphasische Tochterplatten in Polansicht mit je 14 Chromosomen.

Unregelmässigkeiten finden sich in den Reifungsteilungen nur selten, und zwar sieht man in der I. Metaphase hin und wieder 2 Univalente. Meistens liegen sie an den entgegengesetzten Seiten der Äquatorialplatte (in der Richtung der Längsachse der Spindel), so dass in der Anaphase jedes an den näher liegenden Pol (wohl meistens ungeteilt) abwandert, woraus sich in den Tochterplatten vollständige Chromosomengarnituren ergeben. Vielleicht haben die betreffenden Chromosomen, die ja zu einem Paar gehören, miteinander konjugiert und sich nachträglich getrennt. Nur selten sieht man die Univalenten in anderer Lage, wie z.B. in Abb. 8. Hier kann man nicht voraussagen, ob sie an den gleichen Pol gehen werden oder an die entgegengesetzten. Den Verhältnissen in der Metaphase entsprechend gestaltet sich die Anaphase normal (Abb. 9). In dem bis jetzt untersuchten Material konnten in jeder anaphasischen Tochterplatte 14 Chromosomen gezählt werden (Abb. 10). Eine ungleiche Verteilung der Univalenten dürfte also zur Seltenheit gehören. Verzögerte Chromosomen habe ich bis jetzt auch nicht gefunden.

Der Verlauf der II. Reifungsteilung stellte sich ganz regelmässig dar.

### *F. nipponica* ♀ × *F. elatior* ♂

Meine Erfahrungen bei der Herstellung der Verbindung in dieser Richtung entsprechen insofern denen anderer Autoren (vgl. Einleitung), als auch ich zwar guten Ansatz, aber fast ausschliesslich keimunfähige Nüsschen erhalten habe, trotzdem sie nicht anders aussahen wie die bei der reziproken Kreuzung. Von 273 Nüsschen (grossen und kleinen) im ganzen hat nur eins gekeimt. Dieses ergab eine kräftige, auf den ersten Blick auch sehr *elatior*-ähnliche Pflanze, die im Sommer 1932 merklich üppiger war als der Durchschnitt der *elatior*-Sämlinge, also bedeutend üppiger als die reziproken F<sub>1</sub>-Bas tarde. Abb. 22 zeigt ein Blatt dieser Pflanze.

Die Wurzelspitzenuntersuchung ergab 35 somatische Chromosomen, woraus auf die Verdopplung eines der vier von den Eltern beigesteuerten Genome geschlossen werden muss. In dem längeren Stielchen des Endblättchens sowie in seiner scharfen, weiter nach unten herunterlaufenden Randzählung kommt der Einfluss des *nipponica*-Elters, der bei dem reziproken Bastard unterdrückt ist, zum Ausdruck (vgl. Abb. 19–22). Das weist darauf hin, dass die Pflanze zwei *nipponica*-Genome besitzt. Wahrscheinlich war die Eizelle di-



ploid; Diploidie der P.M.Z. und E.M.Z. ist allem Anschein nach keine seltene Erscheinung bei *Fragaria*.

Dieses einzige pentaploide Bastardindividuum war männlich<sup>(1)</sup> (erwartet waren nur Männchen) und blühte recht spärlich. Die Blüten waren kleiner, die Antheren kleiner, dünner und blasser als bei den tetraploiden F<sub>1</sub>-Männchen. Sie platzten nur an trockeneren sonnigen Tagen auf, bei bewölktem Himmel blieben sie geschlossen. Sie enthielten bedeutend weniger Pollen als die der reziproken tetraploiden F<sub>1</sub>-Männchen; unter dem Mikroskop erschien er nur zum kleinen Teil tauglich (Abb. 18). Die Pflanze blühte sehr spät, als schon fast alle anderen Pflanzen verblüht waren, so dass nur wenige Bestäubungen mit ihrem Pollen gemacht werden konnten. Ich habe die Rückkreuzungen zu beiden Eltern versucht, immer mit nur spärlichem Pollen. Nur die Bestäubung von *F. elatior* gelang und ergab eine kleine bucklige Frucht mit 4 guten Nüsschen, von denen 3 keimten. Der Pollen des pentaploiden Bastards war also, in Uebereinstimmung mit dem mikroskopischen Bild, tatsächlich teilweise funktionsfähig.

Die Untersuchung der Reifungsteilungen ergab folgendes. In der I. Metaphase sieht man am häufigsten 14 Bivalente und 7 Univalente (Abb. 11 und 12). Auch hier sind die Zählungen am besten in Polansichten zu machen, trotzdem sich in diesen die in Seitenansichten leicht erkennbaren Univalenten nur schwer von den Bivalenten unterscheiden lassen. Die Anzahl der Univalenten variiert zwischen 5 und 9. Wenn weniger als 7 Univalente vorhanden sind, ist anzunehmen, dass die fehlenden an Bivalente oder tetravalente Komplexe gebunden sind. Die letzteren sind auch hier nicht selten, ebenso wie bei dem reziproken Bastard. Ihre höchste Anzahl pro P.M.Z. konnte auch hier nicht sicher bestimmt werden.

Die Univalenten werden in der Anaphase in den meisten Fällen als Ganze auf die beiden Pole verteilt; ob diese Verteilung eine rein zufallsmässige ist, muss vorläufig dahingestellt bleiben (vgl. weiter unten). Sie werden in der Regel ohne Verzögerung in die Tochter-

(1) Das Gynäzeum war ziemlich gross, aber nicht grösser als bei manchen männlichen *elatior*-Sämlingen. Solche *elatior*-Männchen bezeichnet CORRENS (1928) als nicht rein männlich. Nach seinen Erfahrungen gehen die von ihnen hervorgebrachten Nüsschen nie auf. Bei meiner Pflanze konnte ich im J. 1932 keinen Ansatz feststellen.—Zusatz bei der Korrektur: In diesem Jahre (1933) blühte die Pflanze samt 5 Stecklingen reichlich. In einer von ca. 120 Blüten konnte bei der letzten Aufnahme ein Nüsschen gefunden werden, dessen Keimungsfähigkeit nächstens geprüft werden soll.



kerne einbezogen (Abb. 13). Vereinzelt sieht man aber Univalente sich so verhalten wie in Abb. 14. Hier sind drei verzögerte Univalente zu sehen, die wahrscheinlich in Längsteilung begriffen sind. Hin und

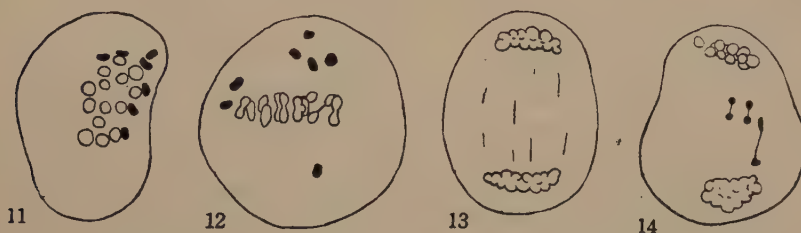


Abb. 11–14.  $F_1$ -Bastard *F. nipponica* ♀ × *F. elatior* ♂. I. Reifungsteilung. Vergr. ca. 2530fach.

Abb. 11. I. Metaphase, Polansicht;  $14_{II} + 7_I$ .

Abb. 12. I. Metaphase, Seitenansicht; 7 Univalente sind sehr leicht zu unterscheiden (eine sichere Analyse der Äquatorialplatte selbst war nicht möglich).

Abb. 13. Telophase; keine verzögerten Chromosomen.

Abb. 14. Telophase; 3 verzögerte Univalente, wahrscheinlich in Längsteilung.

wieder hat man in ähnlichen Fällen den Eindruck, als ob es sich nicht um Längsteilung, sondern um Quersegmentierung bzw. -fragmentierung handelte. Die II. Reifungsteilung verlief in der Regel normal.

Es sei erwähnt, dass die Univalenten keine ausgeprägte Tendenz haben, sich mehr oder weniger gleichmässig über das Spindelareal zu zerstreuen, sondern in kleineren oder grösseren Gruppen auftreten. In seltenen Fällen sieht man alle 7 zusammen liegen. Ob diese Erscheinung einen Einfluss auf ihre anaphasische Verteilung hat, werden künftige Untersuchungen zeigen.

### $F_2$ -Generation (tetraploid $F_1$ ♀ × tetraploid $F_1$ ♂)

Aus den Bestäubungen zweier  $F_1$ -Weibchen mit Pollen einiger  $F_1$ -Männchen habe ich im ganzen 20 Früchte geerntet, die 660 gut ausgereifte Nüsschen von normaler Grösse gaben. Neben solchen kamen auch hier kleinere, meistens blasser gefärbte Nüsschen vor; ihre Anzahl schwankte zwischen 25 und 50% pro Frucht. Um ihre Keimfähigkeit zu prüfen, habe ich ca. 415 getrennt ausgesät; nur zwei haben gekeimt<sup>(1)</sup>, sie waren also fast alle nicht keimfähig.

(1) Die Pflanzen boten nichts Besonderes.

Später habe ich die kleinen Nüsschen noch vorsichtiger herausgelesen und, um Raum zu sparen, von ihrer Aussaat abgesehen. Tab. 1 bringt einige Zahlen, die über das Verhältnis der guten (= gut aussehenden) und der kleinen untauglichen Nüsschen orientieren.

TABELLE 1. Zahlenverhältnis guter und untauglicher Nüsschen. Jahrgang 1932.

Bestäubung	Zahl d. Früchte	Zahl d. guten Nüsschen	Zahl d. untaugl. Nüsschen
$F_1 \times F_1$ (Gewächshaus)	5	215 (56,4%)	166 (43,6%)
<i>elator</i> $\times F_1$ (wie oben)	6	308 (52,0%)	284 (48,0%)
<i>elator</i> frei bestäubt (im Felde)	6	546 (59,7%)	368 (40,3%)

TABELLE 2. Ansatz- und Keimungsverhältnisse (im Gewächshaus).

Verbindung bzw. Selbstung	Zahl d. Früchte	Zahl d. guten Nüsschen	Zahl d. Keimlinge
<i>elator</i> $\times$ <i>elator</i> (1931)	4	119 (28,5 <sup>(1)</sup> )	92 (77,3%)
<i>nipp.</i> $\times$ <i>nipp.</i> (1931)	1	26 —	17 (65,4%)
<i>nipp.</i> selbst (1932)	1	6 —	3 (50%)
$F_1 \times F_1$ (1932)	20	660 (33,0)	ca. <sup>(2)</sup> 499 (75,6%)
<i>el.</i> $\times F_1$ (tetrapl.) (1932)	16	696 (43,5)	ca. 482 (69,2%)
<i>el.</i> $\times F_1$ (pentapl.) (1932)	1	4 —	3 (75%)
$F_1 \times el.$ (1932)	11	171 (15,5)	ca. 147 (86,0%)
<i>nipp.</i> $\times F_1$ (tetrapl.) (1932)	5	146 (29,2)	ca. 32 (21,9%)
$F_1 \times nipp.$ (1932)	1 <sup>(3)</sup>	1 —	0

Von den 660 normalgrossen Nüsschen haben ca. 499 gekeimt (Tab. 2). Leider war, wie schon erwähnt, der Sommer 1932 für

(1) In Klammern: durchschnittliche Anzahl guter Nüsschen pro Frucht.

(2) Die Saattöpfe sind durch ein Versehen Anfang Oktober kassiert worden, bevor die vereinzelt noch hier und da aufgegangenen Keimlinge aufgenommen werden konnten.

(3) Eine sehr kleine, unregelmässige Frucht, die aus einem einzigen Nüsschen bestand, in dessen nächster Umgebung der Blütenboden fleischig geworden ist.

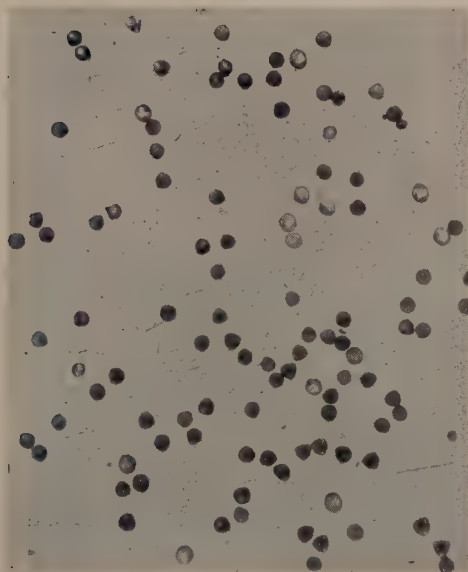


Abb. 15

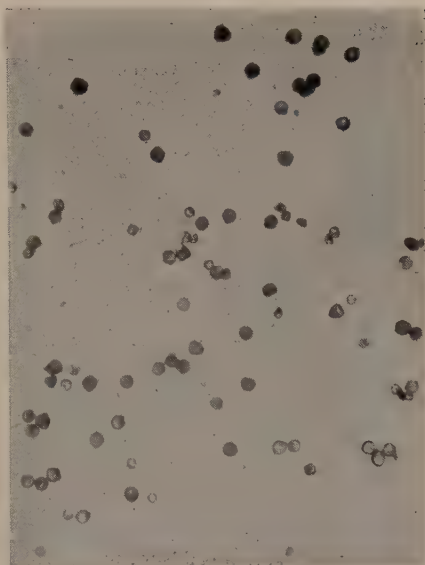


Abb. 16

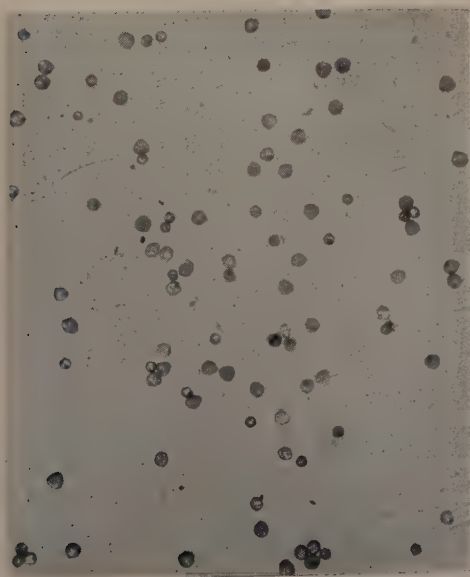


Abb. 17

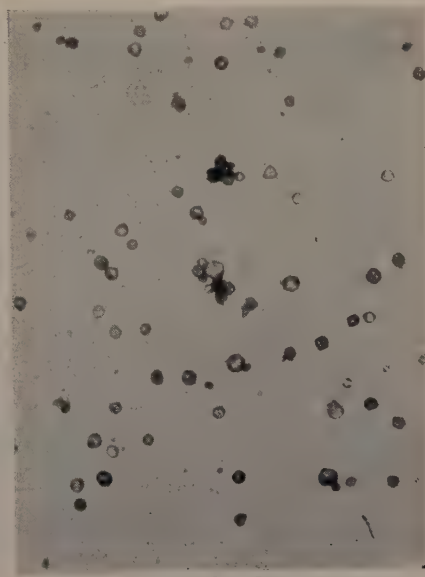


Abb. 18

Abb. 15–18. Pollenkörner. Mikrophotographien.

Abb. 15. *F. nipponica*.

Abb. 16. *F. elatior*.

Abb. 17. F<sub>1</sub>-Bastard *F. elatior* ♀ × *F. nipponica* ♂.

Abb. 18. F<sub>1</sub>-Bastard *F. nipponica* ♀ × *F. elatior* ♂.

die Aufzucht der Keimlinge sehr ungünstig (vgl. S. 427), so dass von 499 ausgesäeten  $F_2$ -Pflänzchen nur 319 (71,1%) am Leben geblieben sind. Die Pflanzen stehen jetzt (Winter 1932/3) im Rosettenstadium und sehen sehr gesund aus.

Diese doch noch ziemlich umfangreiche  $F_2$  bietet das Bild einer sehr reichen Aufspaltung in bezug auf Wüchsigkeit, Habitus, Laubfärbung, Ausläuferbildung, Blattgestalt, Behaarung usw., woraus man auf zahlreiche Faktorenunterschiede zwischen den konjugierenden Genomen schliessen muss (vgl. Diskussion, S. 444). Soweit man jetzt



Abb. 19–37. Blatttypen (Naturdrucke auf Tageslichtpapier). Auf die Hälfte verkleinert.

Abb. 19. *F. elatior*.

Abb. 20. *F. nipponica*.

Abb. 21.  $F_1$ -Bastard *F. elatior* ♀ × *F. nipponica* ♂.

Abb. 22.  $F_1$ -Bastard *F. nipponica* ♀ × *F. elatior* ♂.

Abb. 34–37 (S. 437–8). Verschiedene Blatttypen aus der  $F_2$ -Generation.



schon beurteilen kann, ist im grossen und ganzen der  $F_1$ -Typ am häufigsten vertreten; zu diesem Eindruck trägt freilich in hohem Grad die überwiegend in Erscheinung tretende tetraploide Wüchsigkeit bei. Bei näherer Betrachtung der Einzelheiten kommt man zu der Ueberzeugung, dass die die *elator*- und die *nipponica*-Merkmale bewirkenden Faktoren sich im allgemeinen frei trennen und kombinieren können.



Abb. 23–29. Blatttypen aus  $F_2$ .

Pflanzen, die nicht nur in bezug auf Wüchsigkeit, sondern auch Blattgestalt und Art der Randzählung  $F_1$  bzw. *F. elator* sehr ähnlich sind, begegnet man oft. So ist z.B. das in Abb. 23 gebrachte Blatt von einem *elator*-Blatt kaum zu unterscheiden.

Blattformen, die mehrere *nipponica*-Merkmale vereinigen, findet man hingegen selten (Abb. 25). Ein phänotypisch reines *nipponica*-Blatt in Verbindung mit tetraploider Wüchsigkeit lässt sich wahrscheinlich im Rahmen unserer  $F_2$  nicht nachweisen. Unter den zarten Pflanzen kommen wohl Typen vor, die im ganzen stark an *F. nipponica* erinnern; bei näherer Betrachtung der Blätter stellen sich aber immer einzelne deutliche *elatior*-Merkmale heraus (vgl. Abb. 33). Sonst findet man viele neue, voneinander und von den Eltern stark abweichende Blatt- und Habitustypen, die, im Freien gefunden, sicher



Abb. 30—37. Blatttypen aus  $F_2$ .

nicht zu derselben Art gestellt werden würden. Die extrem abweichenden würde man auf den ersten Blick kaum noch für *Fragaria* halten; sie verdienen in vollem Masse HERIBERT-NILSSONS Bezeichnung "extravagant." So finden sich Pflanzen mit ausgesprochen kriechendem Habitus, ohne Ausläuferbildung, mit kurz gestielten Blättern, die an alpine Potentillen erinnern, eigenartige Typen mit laciniaten Blättern (Abb. 31a, b), Typen mit sehr lang gestielten Teilblättchen (Abb. 29), mit stark runzligen Blättern usw. Auch

weissbunte und variegata Pflanzen kommen vor. Abb. 23–37 sollen die Mannigfaltigkeit der  $F_2$ -Blatttypen illustrieren. Abgesehen von Abb. 23 stellen sie mehr oder weniger seltene und abweichende Typen dar. Sie zeigen, dass in einzelnen Merkmalen (z.B. Randzählung, Breitenindex der Blättchen) auch Transgressionen über die Elterformen hinaus vorkommen können. In bezug auf die Grössenverhältnisse sind die Bilder (besonders die der kleinen Blätter) nicht massgebend, da die Pflanzen zur Zeit ihrer Herstellung (ca. 5 Monate nach der Aussaat) noch ganz jung waren.

In bezug auf Wüchsigkeit kommen, soweit es sich im Herbst 1932 beurteilen liess, ausser dem vorherrschenden tetraploiden Typ einerseits üppigere Pflanzen, anderseits solche vor, die den zarten *nipponica*-Wuchs haben, ferner Zwerge (Abb. 36, 37) und schliesslich ganz winzige Pflänzchen, für die die Bezeichnung von MANGELSDORF und EAST (1927) "Miniaturzwerge" gut passt; ihre Blätter sind so winzig klein, dass man von ihrer Morphologie gar nicht sprechen kann.

Vorläufig muss diese flüchtige und oberflächliche Schilderung der noch nicht fertig entwickelten  $F_2$  genügen. Eine nähere Untersuchung einzelner alternativer und quantitativer (anatomischer und morphologischer) Merkmale soll demnächst angestrebt werden. Es scheint mir aber zweifelhaft, ob sie so weit führen wird, dass sich Faktorenschemata aufstellen lassen. Die grosse Anzahl der Faktoren und die (bei der Mehrzahl der Pflanzen zu erwartende) Getrenntgeschlechtigkeit der  $F_2$  und der weiteren Generationen werden die Untersuchungen in hohem Grade komplizieren. Eine weitere Schwierigkeit könnte sich ergeben, wenn sich unser Bastard als autotetraploid erweisen sollte.

Bis jetzt konnten die Wurzelspitzen von 11  $F_2$ -Individuen untersucht werden. Unter diesen waren sowohl die häufigen als auch die stark abweichenden und seltenen Phänotypen vertreten. Bei 10 Pflanzen (eine war ein Miniaturzwerg) habe ich 28 somatische Chromosomen gefunden, wie erwartet. Eine hatte aber an Stelle eines ganzen Chromosoms ein Fragment. Dieses konnte fast in jeder Äquatorialplatte nachgewiesen werden, so dass die somatische Chromosomengarnitur des betreffenden Individuums sicher aus 27 Einheiten und einem Fragment besteht<sup>(1)</sup>. Es war dies eine sehr abweichende kleine *chlorina*-Pflanze, die einen sehr dichten, dem Bo-

---

(1) Die von mir mit grosser Wahrscheinlichkeit beobachtete Fragmentierung der Univalenten in der I. Reifungsteilung (des pentaploiden  $F_1$ -Bastards) weist auf eine Möglichkeit betreffs der Entstehungsweise dieses Aberranten hin.



den angedrückten Rasen und gar keine Ausläufer bildete. Zwei ihrer Blätter zeigen Abb. 35a und b. Ob und inwiefern das einmalige Fehlen einer Chromosomenstrecke an der geringeren Wüchsigkeit und an dem Zustandekommen der abweichenden morphologischen Merkmale beteiligt war, ist eine interessante Frage.

Die elfte und letzte karyologisch untersuchte  $F_2$ -Pflanze war auffallend derb und grossblättrig. Die Teilblättchen waren sehr rund, dick und sehr grob gezähnt (Abb. 24). Die Zählung ergab 42 Chromosomen, was darauf hinweist, dass einer der beiden Gameten, aus deren Verbindung sie hervorgegangen ist, diploid gewesen sein muss. Es fragt sich, wie wird der Geschlechtsausdruck dieser Pflanze sein. Wenn die Eizelle diploid gewesen ist, dann müsste sie das weibliche Geschlecht zeigen. War aber die P.M.Z. unreduziert, dann kann sie entweder weiblich oder männlich sein (vgl. S. 449).

Das Resultat der karyologischen Untersuchungen lässt sich kurz dahin zusammenfassen, dass die  $F_2$  in der Regel tetraploid ist, wie die  $F_1$ . Manchmal kommen aber Abweichungen vor. Von den zwei gefundenen ist eine auf Chromosomenfragmentierung, die andere auf Verdopplung einer haploiden Chromosomengarnitur zurückzuführen.

## Rückkreuzungsversuche

### *F. elatior* $\times$ $F_1$ (tetraploid) und reziprok

Die Rückkreuzung zum höherchromosomigen Elter, die pentaploide Nachkommenschaft ergeben sollte, gelang in beiden Richtungen ganz leicht. Wie aus Tab. 2 zu ersehen ist, war die durchschnittliche Anzahl guter Nüsschen pro Frucht im Versuch  $F_1 \text{ } \varnothing \times \textit{elatior} \text{ } \sigma$  auffallend klein im Vergleich mit den Bestäubungen der  $F_1$ -Weibchen mit  $F_1$ -Pollen. Da nur ein  $F_1$ -Weibchen für den vorliegenden Rückkreuzungsversuch zur Verfügung stand, kann für diesen Befund vorläufig keine Erklärung gegeben werden. Darauf, dass hier eine strengere Selektion der untauglichen Nüsschen stattgefunden hat, deutet wohl der relativ hohe Keimungsprozentsatz hin — ca. 86,0% gegenüber 75,6% im Versuch  $F_1 \text{ } \varnothing \times F_1 \text{ } \sigma$  (und ca. 69,2% bei der reziproken Verbindung, *elatior*  $\varnothing \times F_1 \text{ } \sigma$ ). Die Differenz reicht aber bei weitem nicht, um das Defizit zu decken.

Sonst bieten die beiden reziproken Rückkreuzungen ein sehr ähnliches Bild und sollen deshalb gemeinsam beschrieben werden.



Von insgesamt 629 Keimlingen sind 421 (66,9%) am Leben geblieben und befinden sich jetzt im Rosettenstadium. Die meisten Pflanzen sehen merklich kräftiger aus als die daneben stehende  $F_2$ -Nachkommenschaft, was mit ihrer Pentaploidie zusammenhängt. Im allgemeinen bieten sie ein viel einheitlicheres Bild als die  $F_2$ , abgesehen von Zwergen und Miniaturpflänzchen, die auch hier vorkommen. Der *elator*-Blatttyp dominiert sehr stark. Unter 421 Pflanzen konnte ich nur eine finden, die bei pentaploider Wüchsigkeit in Blattgestalt und Randzählung *nipponica*-Merkmale aufwies.

Die somatischen Chromosomen sind vorläufig bei 5 Individuen untersucht worden. Bei 4 von diesen fand sich die erwartete Zahl 35, die fünfte hatte aber 36 oder 37 Chromosomen. In manchen Zellen konnte man gut 36, in anderen (in derselben Wurzelspitze!) ebenso sicher 37 zählen. Ich nehme vorläufig die letzte Zahl als die richtige an; dass es sich um eine Mosaikchimäre handeln sollte, scheint mir wenig wahrscheinlich.

### *F. elatior* ♀ × pentaploides $F_1$ -Männchen

Diese Bestäubung ergab, wie oben erwähnt (vgl. Tab. 2), nur 4 gute Nüsschen. Drei haben gekeimt, zwei Pflanzen sind am Leben geblieben. Beide stehen habituell *F. elatior* nahe und haben 35 somatische Chromosomen. Daraus kann man jedenfalls schliessen, dass von den Pollenkörnern des pentaploiden Männchens die 14-chromosomigen am häufigsten die Befruchtung ausführen.

### *F. nipponica* ♀ × $F_1$ ♂ (tetraploid)

Diese Verbindung, aus der triploide Pflanzen zu erwarten waren, gelang zwar leicht, die Keimung war aber ziemlich schlecht. Von 146 gut aussehenden Nüsschen haben nur ca. 32 (21,9%) gekeimt. Die Keimlinge waren normalgross, entwickelten sich aber auffallend langsam und gingen zum grossen Teil noch in den Pikierkisten ein. Achtzehn überlebende Pflänzchen konnten eingetopft werden und sind dank sorgfältiger Pflege am Leben geblieben. Von diesen sehen 8 recht kräftig aus, ungefähr so wie die meisten  $F_2$ -Pflanzen, 7 sind merklich kleiner und 3 zwergig.

Die Untersuchung der Wurzelspitzen bei 3 Pflanzen ergab die erwartete Zahl 21.

Die reziproke Bestäubung,  $F_1 \text{ ♀} \times F. \textit{nipponica} \text{ ♂}$ , hat sonderbarerweise gänzlich versagt, trotzdem das betreffende  $F_1$ -Weibchen sehr reich blühte und alle Blüten bestäubt wurden. Es ging auch nicht viel besser, als ein anderes Weibchen herangezogen wurde. Von diesem konnte zwar ein Nüsschen geerntet werden, es war aber nicht keimfähig.

### Selbstbestäubungsversuch mit *F. nipponica*

Wie oben erwähnt, ist mir im ersten Jahre (1931) keine einzige Selbstbestäubung gelungen, hingegen eine Kreuzung zwischen zwei Individuen. Aus 26 Nüsschen sind 17 Pflanzen erzielt worden, die einen recht einheitlichen Bestand bilden. Im J. 1932 konnte ich bei strenger Selbstbestäubung eine Frucht mit 6 guten Nüsschen ernten. Drei von diesen haben gekeimt; sie ergaben sehr kleine zarte Zwerge, von denen einer eingegangen ist.

### Ergebnisse und Diskussion

1. Aus der Verbindung der hexaploiden *F. elatior* (als Mutter) mit der diploiden *F. nipponica* (als Vater) ging eine tetraploide fertile  $F_1$ -Bastardgeneration hervor, die die Chromosomenzahl 28 weiter vererbte.

In der I. Metaphase der  $F_1$ -Männchen treten in der Regel 14 Gemini auf, von denen 2 bzw. 4 Tetravalente bilden können. Isolierte Chromosomen fanden sich selten; mehr als zwei sind in dem bis jetzt untersuchten Material nicht beobachtet worden<sup>(1)</sup>. Aus diesen Konjugationsverhältnissen muss man schliessen, dass das *nipponica*-Genom mit einem der drei *elatior*-Genome homolog ist und dass die zwei übrigen *elatior*-Genome sich autosyndetisch paaren und miteinander auch homolog sind. Die gute Fertilität der  $F_1$ -Bastarde (vgl. Tab. 1 und 2) weist auf die Austauschbarkeit sämtlicher homologen Chromosomen hin. Wenn wir das *nipponica*- und das mit diesem homologe *elatior*-Genom mit dem allgemeinen Symbol V belegen und die sich autosyndetisch bindenden Genome mit E bezeichnen, dann

(1) Wenn der auf S. 440 besprochene hyperpentaploide Bastard nicht 36, sondern 37 Chromosomen hat, dann sind mehr als 2 Univalente möglich.

können wir die Genomformeln für die beiden Eltern und für den  $F_1$ -Bastard wie folgt angeben:

*F. nipponica*:  $V_{nip.} V_{nip.}$     *F. elatior*:  $V_{el.} V_{el.} E_{(1)} E_{(1)} E_{(2)} E_{(2)}^{(1)}$

$F_1$ -Bastard:  $V_{nip.} V_{el.} E_{(1)} E_{(2)}$ .

Es ist möglich, dass auch zwischen V und E homologe Beziehungen bestehen. Darauf deutet die Neigung zur Bildung von geschlossenen Viererverbänden aus gleich grossen Chromosomen hin. Solange ein Experiment fehlt, das geeignet wäre, die Entscheidung in dieser Frage herbeizuführen, wollen wir sie offen lassen und die betreffenden Genome mit verschiedenen Buchstaben bezeichnen.

Ueber einen sicher autotetraploiden (gemischtgeschlechtigen) *Fragaria*-Bastard berichten ICHIJIMA (1926, 1930) und YARNELL (1929, 1931b). Die Pflanze (ein Individuum) ist in einer Kreuzung zwischen 2 diploiden Arten mit homologen Genomen entstanden, ihre Autotetraploidie ist also experimentell sichergestellt. Auch der Erbgang für Blütenfarbe war nach YARNELL (1931b) der für Autotetraploide erwartete. Es ist angesichts dessen von Interesse, dass ICHIJIMA in der I. Reifungsteilung des Bastards regelmässige Bildung von 14 Gemini beobachtet hat. Dasselbe gibt YARNELL (1931b) für die  $F_2$  an; in der Diakinese konnte er aber gelegentlich ("occasionally") tetravalente Komplexe finden. Also auch bei dieser sicher autotetraploiden Sippe werden in der Regel Gemini, nicht Tetravalente, gebildet. Die  $F_1$ -Pflanze soll charakteristischen Habitus gehabt und sich als konstant erwiesen haben ("breeds true" nach ICHIJIMA 1930). Wilde tetraploide Erdbeeren sind nicht bekannt.

Unsere  $F_1$ -Generation, die aus 44 Individuen bestand, war in bezug auf Wüchsigkeit sehr einheitlich und auch sonst nicht merklich variabler als eine gleichzeitig aus Samen gezogene *elatior*-Nachkommenschaft. Der dominierende Einfluss der *elatior*-Mutter war so stark, dass man die blühenden  $F_1$ -Individuen bei ihrer guten Fertilität ohne weiteres für *F. elatior* hätte halten können<sup>(2)</sup>. Dies

(1) Die E-Genome sind auch mit einer in Klammern gegebenen Indexbezeichnung versehen, da wir vorläufig die Frage offen lassen müssen, ob die Glieder der 4 homologen E-Genome von *F. elatior* bei der reinen Art, die eine wilde Art unbekannten Ursprungs ist, nach dem Zufall oder selektiv—in diesem Fall immer je 2 Glieder aus demselben Genompaar ( $E_1E_1$  bzw.  $E_2E_2$ )—miteinander konjugieren.

(2) Angesichts dessen erscheint die so stark angezweifelte Angabe von MILLARDET (EAST 1928) über das Auftreten von mütterlichen Bastardindividuen in seinen Kreuzungen *elatior*  $\times$  diploid durchaus wahrscheinlich.



ist sicher in erster Reihe damit in Verbindung zu bringen, dass der Genotypus unseres Bastards sich aus den Faktorenbeständen nur eines *nipponica*-Genoms und dreier *elatior*-Genome zusammensetzt. Ausserdem scheint es aber, dass *F. elatior* eine Reihe dominierender Gene der Gattung *Fragaria* (auch im V-Genom) besitzt. Der ausgeprägte *elatior*-Einschlag ihrer Bastarde mit oktoploiden Arten (MANGELSDORF und EAST 1927) spricht dafür.

2. Die  $F_2$ -Nachkommenschaft, die 319 Individuen umfasst, ist, soweit die bisherigen Untersuchungen reichen, in der Regel auch tetraploid, wie zu erwarten war. Auch extravagante Typen und Miniaturpflänzchen weisen die Zahl 28 auf. Bis jetzt habe ich nur 2 Pflanzen mit abweichenden Chromosomenverhältnissen in den Wurzelspitzen gefunden. In einem Fall handelt es sich um die Verdoppelung zweier Genome, wodurch eine hexaploide Pflanze entstanden ist. Wenn wir ihre Entstehung auf Diploidie des mütterlichen oder des väterlichen Gonotokonten zurückführen, eine bei *Fragaria* von ICHIJIMA (1926, 1930) oft beobachtete Erscheinung, dann kann man ihre Genomzusammensetzung ausdrücken in der Formel:  $V_{nip.} V_{el.} E_{(1)} E_{(2)}^{(1)} + V_R E_{(R)}^{(2)}$ . Die zweite Pflanze hatte 27 Chromosomen und ein Fragment. Die Fragmentierung dürfte in der I. Reifungsteilung der  $F_1$ -Mutter oder des  $F_1$ -Vaters stattgefunden haben.

In bezug auf die morphologischen Merkmale zeigt die  $F_2$ , die sich jetzt (Winter 1932/3) im Rosettenstadium befindet, eine ausserordentliche Mannigfaltigkeit. Wir haben hier eine Reihe sehr verschiedener Phänotypen vor uns, die wir, wenigstens theoretisch, als Ausgangsformen von zahlreichen tetraploiden Sippen betrachten können; nach der Stabilisierung dürften nicht wenige den systematischen Wert gangformen von zahlreichen tetraploiden Sippen betrachten können; Getrenntgeschlechtigkeit der Folgegenerationen (vgl. weiter unten) ist es natürlich fraglich, inwieweit dieses Resultat tatsächlich erreicht werden kann. Im allgemeinen kann man aber wohl sagen, dass hier durch die Verbindung verschiedenchromosomiger Eltern nicht nur ein fertiler Bastard mit einer neuen konstanten Chromosomenzahl hervorgebracht wurde, sondern eine ganze Reihe morphologisch gut unter-

(1) Der unreduzierte Gamet.

(2) Der reduzierte Gamet. R = Rekombinationsgenom.



scheidbarer Typen, die die neue Chromosomenzahl gemeinsam haben<sup>(1)</sup>.

Der grosse Formenreichtum weist auf zahlreiche Faktorenunterschiede hin, die man sich folgendermassen zustande gekommen denken kann. 1. Zunächst muss man die Heterozygotie der beiden Eltern in Betracht ziehen; *F. elatior* ist sicher in einer Reihe von Faktoren heterozygot, die *nipponica*-Sämlinge stellen sich einheitlicher dar, spalten aber auch in mehreren Merkmalen auf. 2. Faktorendifferenzen zwischen den *nipponica*- und den mit diesen konjugierenden *elatior*-Chromosomen dürften die wichtigste Ursache der Formenmannigfaltigkeit in  $F_2$  sein. 3. Ferner wäre noch ein drittes Moment zu berücksichtigen. Die somatische Garnitur von *F. elatior* enthält 4 homologe Genome (die E-Genome), mit anderen Worten, *F. elatior* ist teilweise autopolyploid, und zwar autotetraploid. Bei genetisch näher untersuchten Autotetraploiden (bekannte Beispiele liefern *Primula* und *Datura*), die im Experiment entstanden sind, paaren sich je 4 homologe Chromosomen wahllos untereinander. Dasselbe ist nach YARNELL (1931b) der Fall bei seiner sicher autotetraploiden gemischtgeschlechtigen *Fragaria*. Ob die wilden Arten mit vier gleichen Genomen, wie *F. elatior*, sich ebenso verhalten, wissen wir nicht, da keine genetischen Untersuchungen darüber vorliegen. Es ist ebenso möglich, dass hier eine selektive Paarung<sup>(2)</sup> zwischen zwei bestimmten von den je vier homologen Chromosomen stattfindet. Karyologisch besteht ja ein Unterschied in diesem Sinne zwischen der wilden, sicher teilweise autotetraploiden *F. elatior* und der neugebildeten, ebenso sicher autotetraploiden *Fragaria* YARNELLS (sowie meinem vielleicht autotetraploiden Bastard). Während in der I. Reifungsteilung bei der letzteren<sup>(3)</sup> (und auch bei meinem Bastard) eine Tendenz zur Bildung von Tetravalenten besteht, liess sich eine solche in dem sehr umfangreichen von KIHARA (1930) untersuchten *elatior*-Material (von Weibchen und Männchen) weder in Diakinese noch in späteren Stadien nachweisen.

---

(1) Die gegenwärtig im Gange stehenden Untersuchungen der Reifungsteilungen in den P.M.Z. der  $F_2$ -Pflanzen haben bis jetzt, wie erwartet, im allgemeinen regelmässige Paarung der 28 Elemente ergeben (Anm. bei der Korrektur).

(2) Die sich im Laufe der phylogenetischen Entwicklung eingestellt haben könnte. Man kann sich vorstellen, dass bei der starken Konkurrenz zwischen 4 homologen Chromosomen bei der wilden Art schon kleine Differenzen (vielleicht in bezug darauf, inwieweit sie faktoriell miteinander übereinstimmen) dazu führen könnten, dass immer oder fast immer dieselben 2 Chromosomen konjugieren.

(3) In  $F_2$  beobachtet.

Der rein karyologische Befund darf natürlich nicht als beweisend betrachtet werden — nur der Erbgang einzelner Faktoren könnte die Entscheidung bringen. Wenn wir mit diesem Vorbehalt annehmen, dass bei *F. elatior* unter den 4 E-Genomen zwei Genompaare zu unterscheiden sind,  $E_{(1)}E_{(1)}$  und  $E_{(2)}E_{(2)}$  dann würden sich aus dem neuen Paarungsverhältnis,  $E_{(1)}E_{(2)}$ , neue Heterozygotieverhältnisse ergeben, die bei *F. elatior* nicht zustande kämen.

3. Von grösstem Interesse ist selbstverständlich die Vererbung des Geschlechts bei unserem Bastard. Es ist hier zum erstenmal geglückt, einen fertilen Bastard zwischen einer getrenntgeschlechtigen und einer primär gemischtgeschlechtigen Art herzustellen. Es darf allerdings nicht übersehen werden, dass sich aus der teilweisen Autopolyploidie des höherchromosomigen Elters und aus der möglichen Autotetraploidie des Bastards Schwierigkeiten für die weiteren Untersuchungen ergeben könnten.

Die  $F_1$  war getrenntgeschlechtig, wie auch aus der von CORRENS (1926, 1928) festgestellten Heterogametie der *elatior*-Weibchen zu erwarten war. Wenn wir mit CORRENS<sup>(1)</sup> der Getrenntgeschlechtigkeit von *F. elatior* einen männlichen ( $\alpha$ ) und einen weiblichen Realisator ( $\gamma$ ) zugrunde legen, dann müssen wir uns vergegenwärtigen, dass die  $F_1$ -Weibchen nur den Realisator  $\gamma$ , die  $F_1$ -Männchen aber nur einen  $\alpha$ -Realisator besitzen. Beim  $F_1$ -Bastard können also die die Realisatoren enthaltenden Chromosomen<sup>(2)</sup> nie miteinander konjugieren. Wir müssen uns vorstellen, dass in dem homologen Chromosom, mit dem das  $\alpha$ - bzw.  $\gamma$ -Chromosom in der Meiosis der  $F_1$ -Bastarde konjugiert, sich im korrespondierenden (mit dem  $\alpha$ - und  $\gamma$ -) Locus ein Allel befindet, das gar keine sich im Geschlechtsausdruck äussernde Wirkung auf die Geschlechtskomplexe G und A ausübt, in dem Sinne, dass bei Abwesenheit der Chromosomen mit den aktiven Realisatoren ( $\alpha$  oder  $\gamma$ ) Gemischtgeschlechtigkeit in Erscheinung tritt. Mit anderen Worten, wir nehmen im betreffenden

---

(1) Von einem Versuche, GOLDSCHMIDTS Formulierung und quantitative Erklärung heranzuziehen, wollen wir vorläufig absehen. Es soll darauf an Hand der  $F_2$ -Resultate in der nächsten Mitteilung zurückgekommen werden.

(2) Wir wollen sie kurz das  $\alpha$ - und das  $\gamma$ -Chromosom nennen. Ihre morphologische Differenzierung, die bei der Deutung der weiteren Vererbungsversuche ein sehr wertvolles Hilfsmittel abgeben könnte, soll vorläufig unberücksichtigt bleiben.

Locus ein inaktives (oder indifferentes) Gen<sup>(1)</sup> an, das sich wie ein Allel zu den aktiven Realisatoren verhält (in ähnlichem Sinn, wie diese miteinander ein Allelenpaar bilden). Wir wollen es bei den folgenden Ueberlegungen mit + bezeichnen, ganz gleich, ob wir uns die  $\alpha$ - und  $\gamma$ -Chromosomen zum V- oder zu einem der E-Genome zugehörend denken. Ferner müssen wir in Anbetracht der von CORRENS (1926, 1928) festgestellten Geschlechtsverhältnisse annehmen, dass die  $\alpha$ - und  $\gamma$ -Chromosomen bei *F. elatior* selbst nur untereinander konjugieren. Würden die Geschlechtschromosomen zum V-Genom gehören und dieses von E verschieden sein, dann wäre das ja auch die einzige Möglichkeit. Wir haben aber gar keinen Beweis hierfür.

Nach diesen Bemerkungen wollen wir auf die Frage, welche Geschlechtsverhältnisse in  $F_2$  zu erwarten sind, näher eingehen.

Die  $F_1$ -Weibchen und -Männchen bilden zweierlei Gameten:

$$F_1 \text{ ♀ } \begin{cases} 1/2 \gamma \\ 1/2 + \end{cases} \quad \times \quad F_1 \text{ ♂ } \begin{cases} 1/2 \alpha \\ 1/2 + \end{cases}$$

Vorausgesetzt, dass alle vier Gametensorten gleich funktionsfähig sind, ergeben sich für die  $F_2$  folgende zygotische Kombinationen in bezug auf die Realisatoren:  $1/4\alpha\gamma$ ,  $1/4\gamma+$ ,  $1/4\alpha+$  und  $1/4++$ , also Weibchen, Männchen und Zwitter im Verhältnis 2:1:1<sup>(2)</sup>. Während die Männchen denselben Genotypus haben sollten wie in  $F_1$ , sind zweierlei Genotypen für die Weibchen zu erwarten: 1. mit  $\alpha$  und  $\gamma$  und 2. nur mit  $\gamma$ . In  $F_2$  müssten wir also Weibchen mit beiden Realisatoren, wie die *elatior*-Weibchen, bekommen. In der Nachkommenschaft dieser Weibchen, nach der Bestäubung mit Pollen von  $F_1$ -oder  $F_2$ -Männchen, würden sich in  $F_3$   $\alpha\alpha$ -Männchen

(1) Darüber, wie dieses Allel in phylogenetischer Hinsicht zu interpretieren ist (z.B. als Vorstufe der Realisatoren?), lässt sich schwer diskutieren. Solch ein Allel anzunehmen, zwingen die Resultate der neuesten karyologisch-genetischen Untersuchungen, angesichts derer sich der Vorstellung eines "Hinzukommens" von neuen Loci bzw. Genen (im Sinn einer Neubildung) auf so hoher karyologischer Organisationsstufe und in einem so engen Verwandtschaftskreis die grössten Schwierigkeiten entgegenstellen.

(2) Tatsächlich kann man unter den  $F_2$ -Pflanzen morphologische Männchen, Zwitter und Weibchen unterscheiden. Bei mehreren der als Zwitter bestimmten Pflanzen kann man schon jetzt (Mai 1933) guten Ansatz feststellen. (Anm. bei der Korrektur).



einstellen. Von  $F_3$  an hätten wir also in jedem Geschlecht mit zwei Genotypen zu tun.

Ziehen wir nun die Möglichkeit, dass V mit E homolog und der Konjugationsmechanismus autotetraploid ist, auch für die  $\alpha$ -,  $\gamma$ - und die beiden  $+$ -Chromosomen, in Betracht, dann kommt für die  $F_2$  dasselbe Zahlenverhältnis zustande wie oben ( $1/4\alpha\gamma++$ ,  $1/4\alpha+++$ ,  $1/4\gamma+++$  und  $1/4++++$ ). Sobald sich aber  $\alpha\gamma++$ -Weibchen und (in  $F_3$ )  $\alpha\alpha++$ -Männchen eingestellt haben, sollten wir ganz andere Resultate bekommen, da wir bei freier Paarung der betreffenden 4 Chromosomen einerseits mit Gameten ohne Realisatoren, andererseits wieder mit  $\alpha\gamma$ -Eizellen und  $\alpha\alpha$ -Spermakernen zu rechnen hätten. Aus der Kombination der viererlei möglichen<sup>(1)</sup> ♀ und ♂ Gameten derartiger Weibchen und Männchen müssten sich in ihrer Nachkommenschaft folgende Genotypen ergeben:  $9/36\alpha\gamma++$ ,  $9/36\alpha\alpha++$ ,  $6/36\alpha\alpha\gamma+$ ,  $6/36\alpha++++$ ,  $2/36\gamma+++$ ,  $2/36\alpha\alpha\alpha+$ ,  $1/36\alpha\alpha\alpha\gamma$  und  $1/36++++$ . Darunter wären jedenfalls 11 ♀, 17 ♂ und 1 ♀<sup>(2)</sup>. Von besonderem Interesse wäre der Geschlechtsausdruck der Genotypen  $\alpha\alpha\gamma+$  und  $\alpha\alpha\alpha\gamma$ . Bei autotetraploidem Erbgang der Realisatoren würden wir danach, vorausgesetzt, dass die Gameten mit zwei Realisatoren lebensfähig sind, ein passendes Material für eine Untersuchung über die Wirkung verschiedener Realisatorenquantitäten erhalten. Würde sich der Genotyp  $\alpha\alpha\alpha\gamma$  als ♂ manifestieren, dann müssten wir in den weiteren Folgegenerationen auch verschiedene  $\gamma$ -Quantitäten bekommen. Alle diese in Aussicht gestellten Resultate stehen und fallen mit dem autotetraploiden Erbgang der Realisatoren bei den neu erzeugten tetraploiden Genotypen. Es ist durchaus denkbar, dass, sobald zwei Chromosomen mit aktiven Realisatoren vorhanden sind, diese sich auch bei Autotetraploidie unseres Bastards immer oder fast immer selektiv miteinander paaren würden.

In diesem Zusammenhang sei noch hinzugefügt, dass, wenn die Geschlechtschromosomen zu den E-Genomen gehören würden, bei *F. elatior* selbst, die im E-Genom nachgewiesenermassen autotetraploid ist, zwischen den 4 homologen Chromosomen, von denen 2 die aktiven Realisatoren enthalten sollten, hin und wieder ein Partnerwechsel<sup>(3)</sup> stattfinden könnte, der zu einem mutationsähnlichen Auftreten stabiler

(1) Wenn ♀ $\alpha\gamma$ - und ♂ $\alpha\alpha$ -Gameten lebensfähig sind.

(2) Bei diploidem Erbgang dürften natürlich keine Zwitter vorkommen.

(3) Im Sinn einer "Fehlkonjugation."



Zwitter führen müsste. Ähnliches könnten wir erwarten, wenn alle drei *elator*-Genome homolog wären und Autohexaploidie vorläge. Auf diese Möglichkeit sei nur hingewiesen, zum Vergleich mit KUHN'S (1930) Hypothese der Abschwächung (bis auf Null) des männlichen Realisators.

Wir wollen noch ganz flüchtig die bei den Rückkreuzungsbastarden zu erwartenden Geschlechtsverhältnisse streifen, wobei wir nur diploiden Erbgang der Realisatoren berücksichtigen wollen. Bei  $F_1 \varnothing \times \textit{elator} \sigma$  und reziprok haben wir mit folgendem Resultat zu rechnen:

$$1. F_1 \varnothing \begin{cases} 1/2 \gamma \\ 1/2 + \end{cases} \times \textit{el.} \sigma \begin{cases} 1/2 a \\ 1/2 a \end{cases} : 1/2 a\gamma, 1/2 a+.$$

$$2. \textit{el.} \varnothing \begin{cases} 1/2 \gamma \\ 1/2 a \end{cases} \times F_1 \sigma \begin{cases} 1/2 a \\ 1/2 + \end{cases} : 1/4 aa, 1/4 a+, 1/4 a\gamma, 1/4 \gamma+.$$

Es ist also in beiden reziproken Rückkreuzungen zu *F. elator* das selbe Zahlenverhältnis der Geschlechter, nämlich 50% Weibchen und 50% Männchen, zu erwarten. In der Kreuzung *elator*  $\varnothing \times F_1 \sigma$  müssten aber in beiden Geschlechtern zweierlei Genotypen gebildet werden.

In Rückkreuzungen mit dem *nipponica*-Elter haben wir mit folgenden Verhältnissen zu rechnen:

$$\textit{nip.} \varnothing \begin{cases} 1/2 + \\ 1/2 + \end{cases} \times F_1 \sigma \begin{cases} 1/2 a \\ 1/2 + \end{cases} : 1/2 a+, 1/2 ++.$$

Also zur Hälfte Männchen, zur Hälfte Zwitter. Die reziproke Verbindung, die Weibchen und Zwitter in gleicher Zahl ergeben sollte, ist nicht gelungen.

Es sei noch kurz auf das zu erwartende Geschlecht der hexaploiden  $F_2$ -Pflanze (vgl. S. 439) eingegangen. 1. War die Eizelle nicht reduziert, dann erhalten wir:

$$F_1 \varnothing \gamma+ \times F_1 \sigma \begin{cases} 1/2 a \\ 1/2 + \end{cases} : \text{entweder } a\gamma+ \text{ oder } \gamma++, \text{ in beiden} \\ \text{Fällen also ein Weibchen.}$$

2. Ist aber der Spermakern diploid gewesen, dann müssten wir erhalten:

$$F_1 \text{ ♀ } \begin{cases} 1/2 \gamma \\ 1/2 + \end{cases} \times F_1 \text{ ♂ } \alpha + : \text{ entweder } \alpha\gamma + \text{ oder } \alpha + +, \text{ also entweder}$$

ein Weibchen oder ein Männchen. Sollte sich unsere Pflanze als männlich herausstellen, dann müssten wir daraus entnehmen, dass der ♂ Gamet diploid gewesen ist. Mit dieser Bemerkung wollen wir unsere Ueberlegungen über die zu erwartenden Geschlechtsverhältnisse in den Folgegenerationen und Rückkreuzungen unseres Bastards abschliessen. Die Befunde im Sommer 1933 werden zeigen, inwiefern die auf die Annahme von Realisatoren gestützten Voraussetzungen sich bewähren werden.

4. Aus dem Vorhergehenden geht hervor, dass es sehr wünschenswert wäre, einwandfrei festzustellen, ob die Genome V und E in allen Gliedern echt homolog sind, d. h. ob unser Bastard autotetraploid ist. Um diese Frage zu beantworten, können wir verschiedene Wege einschlagen. Der kürzeste bietet sich wohl in der Untersuchung der Reduktionsteilung des mehrmals erwähnten hexaploiden  $F_2$ -Individuums. Wie oben ausgeführt (S. 443), besteht seine Genomgarnitur aus 3 V- und 3 E-Genomen. Sollte es in der I. Reifungsteilung 21 Gemini aufweisen und fertil sein, dann wäre die Homologie der Genome V und E damit bewiesen. Ferner könnte man unsere  $F_1$  mit einer sicher autotetraploiden Pflanze<sup>(1)</sup> aus der *vesca*-Reihe, wie z.B. die von ICHIJIMA und YARNELL untersuchte Autotetraploide, kreuzen. Aus dieser Verbindung würde ein Bastard mit der Genomzusammensetzung VVVE entstehen. Wenn dieser in der Meiosis konstant 14<sub>II</sub> (es könnten auch z.T. Tetravalente vorkommen) aufwies und gut fertil wäre, dann müsste V homolog mit E und unsere  $F_1$  autotetraploid sein. Eine derartige Pflanze steht mir vorläufig nicht zur Verfügung. Ich habe aber triploide Rückkreuzungsbastarde zu dem *nipponica*-Elter als Mutter mit der Genomformel  $V_{nip.} V_R E_{(R)}$ , die zur Hälfte männlich, zur Hälfte zwittrig sein sollen. Unter den von diesen gebildeten funktionsfähigen Gameten sind — in sehr seltenen Fällen — solche mit der Genomgarnitur VVE zu erwarten, die bei wiederholter Verbindung mit *F. nipponica* die gewünschte Genomkombination VVVE ergeben würden. Die Aussicht, auf diese Weise

(1). Deren Genom mit V. echt homolog wäre.

die entscheidende Verbindung zu erhalten, ist praktisch allerdings sehr gering — theoretisch aber möglich. Noch eine andere Möglichkeit ist in der Kreuzung der  $F_1$  mit einer diploiden Art gegeben, deren Genom sicher weder mit V noch mit E homolog wäre. Wenn wir das Genom dieser Art mit N bezeichnen, wäre die Genomformel des Bastards NVE. Im Fall von echt homologen Beziehungen zwischen V und E müssten wir in der Meiosis in der Regel  $7_{II}+7_I$  und zum Teil funktionsfähige Keimzellen bekommen. Eine andere Frage ist es, ob wir bei den diploiden Arten von *Fragaria* ein derartiges Genom finden könnten und, wenn ein solches vorhanden wäre, ob die betreffende Kreuzung sich ausführen liesse und blühende Bastarde ergäbe. Dieser Schwierigkeit würden wir wahrscheinlich in noch höherem Grade begegnen, wenn wir, über die Gattungsgrenzen von *Fragaria* hinausgehend, sicher genomatisch verschiedene *Potentilla*-Arten zum Versuch heranziehen wollten. Es darf ausserdem nicht vergessen werden, dass die Konjugationsweise der 4 homologen Chromosomen, von denen 2 die aktiven Realisatoren enthalten, auch bei nachgewiesener Autotetraploidie eine Ausnahme bilden könnte. In der direkten Untersuchung des Erbgangs der Realisatoren schiene danach das einzige sichere Kriterium in dieser Hinsicht zu liegen, sie könnte aber an der Letalität der  $\alpha\gamma$ - und der  $\alpha\alpha$ -Gameten scheitern.

5. In der reziproken Kreuzung, *F. nipponica* ♀  $\times$  *F. elatior* ♂, habe ich trotz guten Ansatzes nur einen Keimling erhalten. Dieser entwickelte sich zu einem partiell fertilen, sehr kräftigen pentaploiden Männchen. Die morphologischen Merkmale machen es wahrscheinlich, dass das *nipponica*-Genom das verdoppelte ist; die Annahme eines diploiden Embryosacks bei der *nipponica*-Mutter liegt am nächsten. MANGELSDORF und EAST (1927) haben in ihren Kreuzungsversuchen diploid ♀  $\times$  *F. elatior* aus 600 Nüsschen 4 sehr schwächliche Keimlinge erhalten, die bald nach der Keimung eingingen. Dieses Resultat, mit dem meinen verglichen, legt den Gedanken nahe, dass die heptaploide Beschaffenheit des Endosperms mit der normalen Entwicklung des pentaploiden Embryo in ursächlichem Zusammenhang stehen könnte. Gegen diese Deutung sprechen aber die Erfahrungen, die bei den Kreuzungen zwischen di- und oktoploiden Arten gemacht wurden (SCHIEMANN 1930, YARNELL 1931a). Es ist zwar auch hier ein Unterschied zwischen den reziproken Verbindungen in demselben Sinne wie bei *F. nipponica*  $\times$  *F. elatior* gefunden worden, insofern als diploid ♀  $\times$  oktoploid ♂ einen viel schlechteren Keimungsprozentsatz ergab als die reziproke Verbin-



dung. Man konnte aber auch bei diploider Mutter neben schwächlichen Pflanzen kräftige Bastarde mit der erwarteten Chromosomenzahl erzielen, trotzdem das Endosperm in diesem Fall nur hexaploid war. Daher muss die Frage nach der Bedeutung der Verdopplung eines Genoms bei dem Zustandekommen des einzigen lebensfähigen Bastards im Versuch *F. nipponica* ♀ × *F. elatior* ♂ vorläufig offen bleiben.

In der I. Reifungsteilung dieses pentaploiden Bastards war in der Regel die Chromosomenkombination  $14_{II} + 7_I$  verwirklicht. ICHIJIMA (1926, 1930) und YARNELL (1931a) haben die oben erwähnten pentaploiden Bastarde zwischen diploiden und oktoploiden Arten karyologisch untersucht. ICHIJIMA gibt  $7_{II} + 21_I$ , YARNELL Tendenz zur "vollständigen" Paarung an. YARNELL deutet sein Resultat dahin aus, dass die oktoploiden Arten autooktoploid seien, dass das Genom der diploiden Arten sich mit einem ihrer 4 Genome paare, ferner, dass sich zwei weitere von diesen autosyndetisch binden und, schliesslich, dass die Glieder des überschüssigen Genoms ("non homologous" (?) "chromosomes of a single genom") sich untereinander paaren. Eine ebenfalls "vollständige" Paarung will er auch bei seinen triploiden (autotetraploid × diploid-) Bastarden beobachtet haben, die sicher ihrer Entstehungsweise nach autotriploid sind, und interpretiert sie auf dieselbe Weise. Diese Behauptung muss betreffs der triploiden Bastarde auf einem Beobachtungsfehler beruhen. Bei drei echt homologen Genomen ist 7 die höchste mögliche Anzahl der (bi- bzw. trivalenten) Bindungen; Chromosomen ein und desselben isolierten Satzes können untereinander keine Paare bilden<sup>(1)</sup>. YARNELL beruft sich auf JENKINS (1929), der bei dem triploiden Bastard *Aegilops speltoides* × *Triticum durum* 10 Bindungen beobachtet hat, die er, fälschlicherweise, ebenso wie YARNELL interpretiert. Die beiden Fälle sind aber nicht vergleichbar, da der betreffende *Aegilops* × Weizenbastard sicher allopolyploid ist. Bei einem solchen können selbstverständlich bis zu 10 Bindungen zustande kommen, sie müssen aber anders erklärt werden (KIHARA u. NISHIYAMA 1930, KIHARA u. LILIENFELD 1932). Ob YARNELLS Angaben für seine pentaploiden Bastarde den Tatsachen entsprechen, lässt sich nicht ohne weiteres sagen. Ist seine Annahme der Auto-

(1) So etwas wäre nur dann möglich, wenn Translokationen und in deren Folge Reduplikationen stattgefunden hätten. Für eine derartige Annahme bei *Fragaria* liegen vorläufig nicht die geringsten Anhaltspunkte vor.



oktoploidie der 56-chromosomigen Arten richtig, dann muss seine Beobachtung auch in diesem Fall auf einem Irrtum beruhen. Da wir vorläufig keinen Beweis dafür haben, dass die n-Chromosomen-garnitur der oktaploiden Arten aus 4 homologen Genomen besteht, muss diese Frage unentschieden bleiben. Ganz abweichend von YARNELLS Befund ist jedenfalls der von ICHIJIMA, der (für dasselbe Material)  $7_{II}$  und  $21_I$  in der I. Reifungsteilung angibt. Auch die Richtigkeit dieser Angabe möchte ich bezweifeln. KIHARA (1930) hat bei dem heptaploiden Bastard *F. grandiflora* ♀ × *F. elatior* ♂ die Chromosomenkombination  $21_{II} + 7_I$  (bzw. Modifikationen davon) gefunden<sup>(1)</sup>. Es liegt am nächsten, nach diesem Resultat anzunehmen, dass *F. grandiflora* ein V-Genom und entweder 2 E- oder zwei von E verschiedene, miteinander homologe und sich autosyndetisch bindende Genome hat. Ueber das vierte, bei dieser Annahme beim heptaploiden Bastard isoliert bleibende *grandiflora*-Genom lässt sich nichts sagen. Danach müssten bei pentaploiden Verbindungen zwischen diploiden Arten (aus der *vesca*-Reihe) mit oktaploiden wenigstens 14 Gemini gebildet werden.

6. Die Ausführung der Rückkreuzung *elatior* ♀ ×  $F_1$  ♂ (tetrapl.) und reziprok bot keine Schwierigkeiten. Soweit die Untersuchungen reichen, sind die Bastarde, wie erwartet, pentaploid (1 Individuum stellte sich als hyperpentaploid heraus). Ihre Genomzusammensetzung ist  $V_{el} V_R E_{(1)} E_{(2)} E_{(R)}$ , im Gegensatz zu dem pentaploiden  $F_1$ -Bastard *F. nipponica* ♀ × *F. elatior* ♂, dessen Genomformel wir als  $V_{nip} V_{nip} V_{el} E_{(1)} E_{(2)}$  angenommen haben. Es sind also wahrscheinlich in meinem Material zweierlei pentaploide Genomkombinationen vorhanden.

In diesem Zusammenhang ist es bemerkenswert, dass YARNELL (1931b) bei den Versuchen, seine Autotetraploide mit *F. elatior* zu kreuzen, wenn letztere die Mutter war, guten Ansatz, aber keine keimfähigen Nüsschen erhalten hat, während die reziproke Bestäubung 16 lebensfähige, sehr kräftige Pflanzen ergab. Ich konnte keinen derartigen Unterschied zwischen den beiden reziproken Kreuzungsversuchen mit meinem tetraploiden Bastard und *F. elatior* beobachten (Tab. 2).

Die Rückkreuzung *F. elatior* ♀ × pentapl.  $F_1$ -Bastard ♂ lieferte nur 3 Keimlinge, von denen 2 am Leben blieben. Beide haben 35

(1) Die Bastarde, lauter Männchen, lieferten teilweise funktionsfähigen Pollen (CORRENS 1928).

somatische Chromosomen. Daraus geht jedenfalls hervor, dass die 14-chromosomigen Pollenkörner des pentaploiden Bastards die funktionsfähigsten sind.

7. Die Rückkreuzung *F. nipponica* ♀ × F<sub>1</sub> ♂ (tetrapl.) ergab einen Keimungsprozentsatz von nur 21,9%. Die Sämlinge entwickelten sich auffallend langsam und gingen zum grossen Teil noch in den Pikierkisten ein. Die Bastarde sind, soweit die Untersuchungen reichen, triploid, wie erwartet. Die reziproke Bestäubung gab fast keinen Ansatz (1 nicht keimfähiges Nüsschen). Auch YARNELL (1931b) gibt für seine Autotetraploide an, dass die Verbindung diploid ♀ × tetraploid ♂ viel besser gelänge als die reziproke.

8. Wenn wir die in der Literatur vorliegenden Angaben über den Erfolg in Kreuzungsversuchen mit *Fragaria*-Arten vergleichen, gewinnen wir den Eindruck, dass *Fragaria* eine in dieser Beziehung ausserordentlich launische Pflanze ist. So wollen manche Kreuzungen gar nicht gelingen, z.B. die von *F. elatior* mit verschiedenen diploiden Arten, bis einmal plötzlich eine ohne weiteres geht, wie in meinem Versuch mit *F. nipponica* als diploide Art. Noch auffälliger ist es, dass in dem Verhalten der reziproken Verbindungen sich keine Gesetzmässigkeit feststellen lässt. Die allgemein geltende Regel (KIHARA u. NISHIYAMA 1932), dass eine Verbindung in der Richtung höherchromosomig ♀ × minderchromosomig ♂ erfolgreicher ist als die reziproke (d.h. einen höheren Keimungsprozentsatz ergibt/wenn beide gelingen/), trifft in manchen Kreuzungen zu, wie bei *F. nipponica* × *F. elatior*, und diploid × oktoploid, in anderen aber nicht (vgl. meine Rückkreuzungen *nipponica* ♀ × F<sub>1</sub> ♂ und reziprok). Im Zusammenhang damit steht es, dass sich die Angaben verschiedener Autoren oft widersprechen. So geben MANGELSDORF und EAST (1927) an, die Verbindung diploid × oktoploid wäre nur in dieser Richtung möglich, während YARNELL (1931a), wohl an gleichem Material, feststellt, dass beides geht, aber die Verbindung oktoploid ♀ × diploid ♂ einen viel besseren Keimungsprozentsatz aufweist als die reziproke. Wenn man dies alles in Betracht zieht, ist man geneigt, anzunehmen, dass 1. jede Kreuzung zwischen zwei *Fragaria*-Arten, in deren Genomgarnituren sich homologe Genome finden, im Prinzip wenigstens in einer Richtung möglich ist<sup>(1)</sup> und dass 2. auch bei *Fragaria* der Er-

(1) Abgesehen davon, dass in Einzelfällen gewisse Faktorenkombinationen Inkompatibilitätserscheinungen hervorrufen könnten.

folg einer Kreuzung zwischen zwei verschiedenchromosomigen Arten viel besser ist, wenn die höherchromosomige die Mutter ist. Die Abweichungen von dieser Regel sind wahrscheinlich sekundärer Natur, durch Faktoren verursacht, deren Analyse die Aufgabe künftiger Untersuchungen sein wird.

9. Verdopplung von Chromosomenzahlen scheint bei *Fragaria* keine Seltenheit zu sein. Die Umstände, unter denen erhöhte Chromosomenzahlen beobachtet wurden, sprechen dafür, dass sie sich in den meisten Fällen am einfachsten durch Diploidie der Keimzellen erklären lässt. YARNELL (1931b) nimmt an, dass seine Autotetraploide infolge von Chromosomenverdopplung im somatischen Gewebe entstanden ist, was auch sehr möglich ist. Er gibt an, einen derartigen Fall in einer ähnlichen Kreuzung sicher festgestellt zu haben. Die ungeschlechtliche Vermehrung durch Ausläufer, die bei *Fragaria* eine sehr wichtige Rolle spielt, wirkt der Differenzierung der Genome entgegen. Dieser Faktor, in Verbindung mit Verdopplungen der Chromosomengarnituren, sei es in Gonotokonten, sei es in Somazellen, begünstigt die Entstehung von autopolyploiden Reihen. Es fragt sich nun, wie verhält es sich in Wirklichkeit mit den in der Natur gefundenen polyploiden Erdbeeren? Sind sie allo- oder autopolyploid? Bis jetzt sind nur hexa- und oktoploide Arten gefunden worden; wilde Tetraploide sind nicht bekannt. Die hexaploide *F. elatior* ist, wie mein Kreuzungsversuch mit *F. nipponica* gezeigt hat, mindestens autotetraploid. Aus der Bildung von 1–2 geschlossenen Viererkomplexen in der Meiosis der  $F_1$ -Pflanzen könnte auf Homologie aller 3 *elatior*-Genome geschlossen werden. Von den 4 Genomen von *F. grandiflora* (die ein Bastard zwischen *F. chiloensis* und *virginiana* sein soll) müssen auch mindestens 2 homolog sein. Vorläufig wissen wir also nur, dass die polyploiden Erdbeeren sicher teilweise autopolyploid, und zwar autotetraploid sind. Die sich an diese Ueberlegungen knüpfende Frage, ob sich unter diploiden *Fragaria*-Arten solche mit weitgehend verschiedenen Genomen finden und ob sie kreuzbar wären, haben wir oben berührt. Angesichts der Unsicherheit der Kreuzungsergebnisse bei dieser Gattung, muss sie vorläufig unbeantwortet bleiben.

10. Zuletzt wäre noch die Frage der Zwerge zu erörtern. SCHIEMANN (1930) führt Zwerge, die sie in intraserialen Kreuzungen erhalten hat, auf ♀ Sterilitätsfaktoren zurück, während sie geneigt ist, als Ursache der Zwergbildung in interserialen  $F_1$ -Ver-



bindungen Faktorenkombinationen anzunehmen. Meine  $F_1$  war in bezug auf Wüchsigkeit ganz einheitlich—Zwerge traten erst in  $F_2$  und in Rückkreuzungen auf. Zu ihrer Erklärung möchte ich in erster Linie Faktorenkombinationen annehmen. In Einzelfällen könnte es sich aber meiner Ansicht nach um Chromosomenaberranten handeln. Das Vorhandensein der erwarteten Chromosomenzahl beweist noch nicht die Intaktheit des Chromosomensortiments, wie am besten meine  $F_2$ -Pflanze mit 27 Chromosomen + 1 Fragment zeigt. In diesem Fall konnte die Abweichung dank der Kleinheit des Fragments nachgewiesen werden. Stellen wir uns aber vor, dass von einem Chromosom nur ein kleines Stückchen oder sogar die Hälfte fehlt, dann müssten in jedem Einzelfall karyomorphologische Studien herangezogen werden, um den Defekt festzustellen.

Zu der Erfahrung von SCHIEMANN mit intraserialen Zwergen möchte ich bemerken, dass ich sogar bei Selbstbestäubungen von *F. nopponica* entweder keinen Ansatz oder, in einem Fall, drei zwergige Pflänzchen erhalten habe, während eine Kreuzung von 2 Stöcken normale Nachkommenschaft ergab. Bei *F. nipponica* kann es sich sicher nicht um ♀ Sterilitätsfaktoren handeln, da sämtliche von mir zu Kreuzungen benutzten Stöcke auf beiden Seiten vollfertil waren. Wie gut der Pollen aussah, zeigt Abb. 15. Da meinen Beobachtungen nur ein spärliches Material zugrunde liegt, kann ich vorläufig keine Erklärung für diese Zwergbildung geben.

11. Polyploide  $F_1$ -Bastarde mit konstanter Geminibildung zwischen verschiedenchromosomigen Eltern hat zuerst LJUNGDAHL (1924) in Kreuzungen von *Papaver nudicaule* ( $n=7$ ) mit *P. radiatum* ( $n=35$ ) und mit *P. striatocarpum* ( $n=35$ ) erhalten; sie waren hexaploid. Leider gehen die Angaben nicht über karyologische Verhältnisse in  $F_1$  (neben einer flüchtigen Bemerkung über die  $F_2$ ) hinaus. Es wird nur noch die Fertilität der  $F_1$ -Bastarde kurz erwähnt. Die zuerst genannte Verbindung war schwach, die zweite gut fertil.

Ueber einen ähnlichen (oktoploiden), hochfertilen Bastard zwischen *Chrysanthemum* (Grundzahl = 9) *marginatum* ( $n=45$ ) und *Ch. morifolium* ( $n=27$ ) hat in der letzten Zeit SHIMOTOMAI (1931, 1932) berichtet. Bei den  $F_1$ -Pflanzen hat er regelmässig 36 Gemini beobachtet. Es ist sehr bemerkenswert, dass die aus 482 Individuen bestehende  $F_2$  sich trotz erheblicher Unterschiede zwischen den Eltern ziemlich einheitlich und der  $F_1$  ähnlich darstellen soll.



Sonst liegen nur noch wenige, ganz unvollständige Angaben über derartige Bastarde vor. So berichtet DARLINGTON (1927) über einen tetraploiden *Prunus*-Sämling aus der Verbindung *Prunus domestica* ( $n=24$ )  $\times$  *P. cerasifera* ( $n=8$ ), dessen Reifungsteilungen ebenso verlaufen sollen wie bei einer beliebigen wilden tetraploiden *Prunus*-Art. Es wird nur dieser karyologische Befund angegeben. Ob der Bastard fertil war, geht aus der Darstellung nicht hervor. HAASE-BESSELL (1921) teilt über einen sterilen Bastard zwischen *Digitalis micrantha* ( $n=24$ ) und *D. lutea* ( $n=48$ ) mit, bei dem sie 36 Gemini gefunden hat. Schliesslich entnehme ich aus RENNER (1928) die Angabe über einen hexaploiden Bastard mit normaler Chromosomenpaarung zwischen *Betula verrucosa* ( $n=14$ ) und *B. pubescens* ( $n=28$ ) (HELMS und JORGENSEN 1925). Ueber seine Fertilität ist nichts gesagt.

Die Entstehung fertiler Pflanzenbastarde mit normalen Konjugationsverhältnissen in der Meiosis aus Verbindungen von verschieden-chromosomigen Arten gehört also zur grossen Seltenheit. Von den wenigen oben besprochenen Fällen sind nur zwei, nämlich die *Papaver*-Bastarde und der *Chrysanthemum*-Bastard sicher mit dem hier beschriebenen vergleichbar. Der Grund für das so seltene Auftreten derartiger Bastarde ist wohl darin zu suchen, dass ihr Zustandekommen wenigstens teilweise strenge Autopolyploidie des höher-chromosomigen Elters verlangt<sup>(1)</sup>. Autopolyploidie scheint aber in der Natur viel seltener zu sein als Allopolyploidie.

Herrn Prof. Dr. H. KIHARA, der mir die Ausführung der Versuche in so grossem Massstab ermöglichte und mich auch bei den karyologischen Studien in bereitwilligster Weise mit Rat und Tat unterstützte, spreche ich auch an dieser Stelle meinen herzlichsten Dank aus. Auch Herrn Dr. I. NISHIYAMA bin ich für die sorgfältige Anfertigung der mikroskopischen Bilder zum besten Dank verpflichtet.

---

(1) Und Uebereinstimmung mit dem minderchromosomigen in bezug auf die übrigen Genome. Bei vollständiger Autopolyploidie des höherchromosomigen Elters müssten selbstverständlich beide dasselbe Genom, nur in verschiedener Anzahl, besitzen, mit anderen Worten, verschiedene Stufen derselben Polyploidie-Serie darstellen.

## Zitierte Literatur

- CORRENS, C., 1926. Ueber Fragen der Geschlechtsbestimmung bei höheren Pflanzen. Ztschr. f. ind. Abst.- u. Vererbgs. **41**.
- 1928. Bestimmung, Vererbung und Verteilung des Geschlechts bei den höheren Pflanzen. Handb. d. Vererbgs. Bd. II C.
- DARLINGTON, C. D., 1927. The behaviour of polyploids. *Nature* **118**.
- EAST, E. M., 1928. Heredity in the genus *Fragaria* with special reference to the false hybrids of Millardet. Ztschr. f. ind. Abst. u. Vererbgs. Suppl.-Bd. I.
- HAASE-BESSELL, G., 1921. Digitalisstudien II. Ztschr. f. ind. Abst. u. Vererbgs. **27**.
- HELMS, A. u. C. A. JÖRGENSEN, 1925. Birkene paa Maglemose. Bot. Tidsskr. **39**.
- ICHIJIMA, K., 1926. Cytological and genetic studies on *Fragaria*. *Genetics* **11**.
- 1930. Studies on the genetics of *Fragaria*. Ztschr. f. ind. Abst.- u. Vererbgs. **55**.
- JENKINS, J. A., 1929. Chromosome homologies in wheat and *Aegilops*. *Am. Journ. Bot.* **16**.
- KIHARA, H., 1926. Ueber die Chromosomenverhältnisse bei *Fragaria elatior*. Ztschr. f. ind. Abst.- u. Vererbgs. **41**.
- 1930. Karyologische Studien an *Fragaria* mit besonderer Berücksichtigung der Geschlechtschromosomen. *Cytologia* **1**.
- KIHARA, H. u. I. NISHIYAMA, 1930. Genomanalyse bei *Triticum* und *Aegilops*. I. *Cytologia* **1**.
- 1932. Different compatibility in reciprocal crosses of *Avena*, with special reference to tetraploid hybrids between hexaploid and diploid species. *Jap. Journ. Bot.* **6**.
- KIHARA, H. u. F. LILIENFELD, 1932. Genomanalyse bei *Triticum* und *Aegilops* IV. *Cytologia* **3**.
- KUHN, E., 1930. Die Geschlechtsformen bei *Fragaria* und ihre Vererbung. *Der Züchter* **2**.
- LJUNGDAHL, H., 1924. Ueber die Herkunft der in der Meiosis konjugierenden Chromosomen bei *Papaver*-Hybriden. *Svensk Bot. Tidskr.* **18**.
- MANGELSDORF, A. J., u. E. M. EAST, 1927. Studies on the genetics of *Fragaria*. *Genetics* **12**.
- RENNER, O., 1929. Artbastarde bei Pflanzen. Handb. d. Vererbgs. Bd. II A.
- SCHIEHMANN, E., 1931. Geschlechts- und Artkreuzungsfragen bei *Fragaria*. Bot. Abhandl. **18**.
- SHIMOTOMAI, N., 1931. Bastardierungsversuche bei *Chrysanthemum*. I. *Journ. of Sci. of the Hiroshima University*.
- 1932. Bastardierungsversuche bei *Chrysanthemum*. II. *Ibidem*.
- YARNELL, S. H., 1929 a. Notes on the somatic chromosomes of the seven-chromosome group of *Fragaria*. *Genetics* **14**.
- 1929 b. Meiosis in triploid *Fragaria*. *Proc. Nat. Acad. Sci. Wash.* **15**.
- 1931 a. Genetic and cytological studies on *Fragaria*. *Genetics* **18**.
- 1931 b. A study of certain polyploid and aneuploid forms in *Fragaria*. *Genetics* **16**.

# Identification of the sexes in dioecious plants by testing the resistance to the toxic action of chlorate<sup>(1)</sup>

By Morimasa YAMASAKI

---

With 4 figures in text

---

(Received March 6, 1933)

## Introduction

In the previous paper (9), the author has insisted upon that in crop plants, such as rice, wheat and barley, the resistance to the toxic action of potassium chlorate,  $\text{KClO}_3$ , varies markedly with varieties concerned, and is moreover concurrent with their physiological characteristics—say the resistance to drought (in case of rice) or that to cold (in case of wheat and barley). He further tried some experiments with dioecious plants, and found that the resistance to the toxicant also varies according to different sexes, which seems to throw some light upon the problem on the sex diagnosis.

As regards the sexual differences concerning chemical or physico-chemical properties only a few studies have been reported in plants, though much more in men and animals. So far as the author is aware, MANOILOV (2, 3) has found the reagent by which it is possible, in plants, to distinguish the male from the female and SATINA (5), GRÜNBERG (1) and MINENKOV (4) made experiments by applying the reagents found by MANOILOV to certain plants, and obtained results which agree closely with those of the latter's experiments. TADOKORO (6, 7, 8) pointed out that the male differs from the female in regard to the activity of some kinds of enzymes having oxydizing or reducing action.<sup>(2)</sup>

---

(1) This work was done by the author when he was at the Imperial Agricultural Experiment Station, Tokyo.

(2) Cf. the editor's remark at the end of this paper.—EDITOR.

In the present experiments, dioecious plants, such as spinach (*Spinacia oleracea*), hemp (*Cannabis sativa*) and *Ginkgo biloba*, L. were used as materials. The test of the resistance to the toxicant was conducted in greenhouse from March to May, 1932. The experimental method employed as well as the results obtained are to be set forth in the present paper.

### Experiments with spinach

The seeds were sown in greenhouse in the fall of 1931, and in March of the next year when plants bore flowers, the males and females were subjected to the following treatment, the air temperature during the experiment being 20–22°C in maximum and 12–14°C in minimum. The plants at nearly the same growth stage, 5–6 in number for each sex, were chosen out and they were taken to water culture. After a few days they were allowed to absorb the chlorate by means of the culture in 0.03% solution of the salt in the dark for 24 hours, and then they were cultivated in pure water, being exposed to the sun.

One or two days after the treatment described above, the plants were found to be injured by the toxicant which they had absorbed, the females withering much more than the males. This is seen clearly in Fig. 1 and is also shown in Table I.



Fig. 1

Another series of experiments were also conducted with the leaves instead of the whole plants, the method applied being alike that above described. The results obtained are exactly the same as those mentioned above, as shown in Fig. 2.



TABLE I. Sexual differences in spinach in regard to the resistance to the toxic action of chlorate.

Experiments	Date of the solution culture	Date of the water culture	Symptoms of injury one day after the water culture	
			male	female
I	7 March	8 March	±	+
II	9 „	10 „	±	±
III	17 „	18 „	±	+
IV	21 „	22 „	±	±
V	23 „	24 „	±	±
VI	24 „	25 „	±	+

Note: The symptoms of injury is denoted by symbols, ± (slight), ± (moderate) and + (severe). This denotation is also adopted in experiments with hemp and *Ginkgo*.

Moreover, in May 1932, the experiments were also made with plants planted out-door, showing the results similar to those got with plants grown in greenhouse.

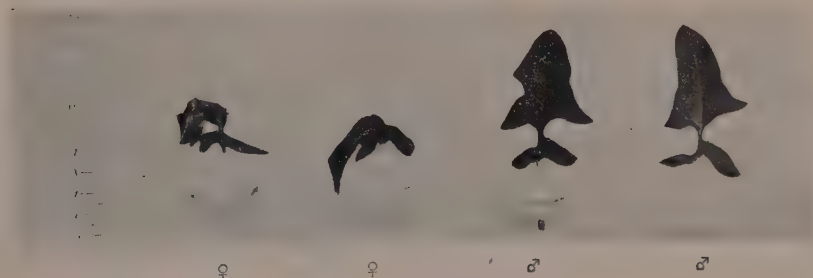


Fig. 2

From the results obtained in the above investigations, it can be concluded that, in spinach, the females are far more susceptible to the toxicant action than the males.

### Experiments with hemp

The plants used were grown in greenhouse in the spring of 1932. After flower bearing, they were treated as explained below,

the air temperature during the experiment being 23–25°C in maximum and 13–15°C in minimum. At first, the males and females, each 5–6 in number, which were at nearly the same stage of growth were chosen out and, after being cultivated in water for a few days, they were rendered, in the dark, to absorb the chlorate by being cultivated in 0.05% solution of the salt for 20 hours. Then they were cultivated in pure water under the sunshine as in the experiment with spinach. The next day, the symptoms of injury caused by the toxicant could be seen on the leaves of plants treated.

The experiments were repeated four times according to the same method, the results obtained being shown in Table II.

TABLE II. Sexual differences in hemp in regard to the resistance to the toxic action of chlorate.

Experiments	Date of the solution culture	Date of the water culture	Symptoms of injury one day after the water culture	
			male	female
I	3 April	4 April	±	+
II	5 „	6 „	±	±
III	7 „	8 „	±	+
IV	9 „	10 „	—	+

From the Table, it is noticed that the females are injured badly

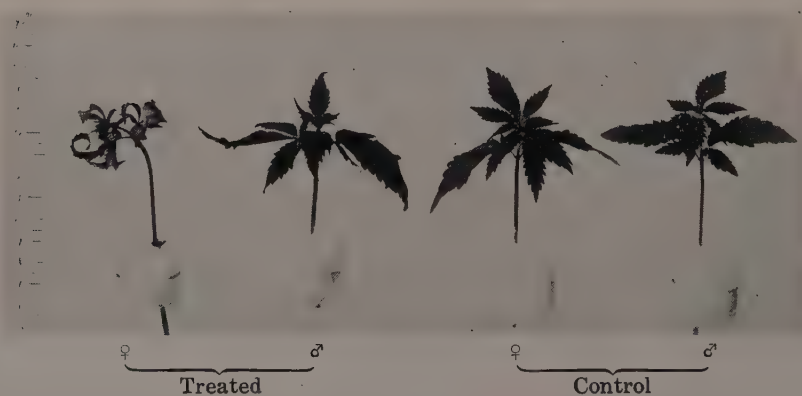


Fig. 3

while the male only slightly. This is visible also in Fig. 3.

In another experiment, the stems only were used as materials, and the results therefrom were exactly like those obtained in the experiments with the whole plants.

### Experiments with *Ginkgo*

In the experiments, I have used as materials twigs of *Ginkgo biloba*, the sex of which are known. The experiments can be divided conveniently in two classes in regard to the source of plants used. In one experiment (denoted by A), the male and female used were growing side by side at Kusu village near the Imp. Agr. Exp. Station where the study was made, their height being nearly equal, i.e., both about 10 meters high. In the other (denoted by B), the male and female were standing nearby at Saitama village, and both attained 15 meters in height, showing that they are probably older than those used in the experiment (A).

Both experiments noted above were made in May 1932, the air temperature being 23–25°C in maximum and 13–15°C in minimum throughout the investigation.

The twigs of the tree, nearly similar in size, were taken off and treated as follows. They were put in water for about one day and then in 0.1% solution of the salt in the dark for 48 hours. Next, the twigs were again put in pure water under the sunshine. Two or three days after the treatment noticed above, the injury of the leaves by the toxicant was seen to be severe in the females and slight in the males. This is shown in Table III as well as in Fig. 4.

TABLE III. Sexual differences in *Ginkgo* in regard to the resistance to the toxic action of chlorate.

Experiments	Date of the solution culture	Date of the water culture	Symptoms of injury two days after water culture	
			male	female
A {	I 7 May	9 May	±	+
	II 10 „	12 „	±	+
B {	I 15 „	17 „	±	+
	II 19 „	21 „	±	+



Fig. 4

## Discussion

All the experiments of dioecious plants above described have led to the concordant results, i.e. the male is more resistant against the toxicant than the female. This fact seems to be of much importance, not only for the sexual identification but also for sex physiology of plants.

As regards the physiology of the toxic action of chlorate as well as that of the resistance to the toxicant, the author had put forward the hypothesis in the previous study (10), as is shown below. The chlorate itself is practically harmless to plants, but the salts are reduced by the reducing substances contained in plants, such as glucose, aldehydes, etc., resulting in the formation of hypochlorite which acts directly poisonous on plants and consequently the resistance to the toxicant is dependent on the amount of the substances concerned, i.e. the more the amount of the latter, the less the resistance to the toxicant.

In that case, it can be assumed that the content of reducing substances might vary according to the sexes, i.e. the female might have them much more than the male. To ascertain the assumption noted above, the author made experiments with spinach as well as *Ginkgo* in which the relative quantity of reducing substances of the leaves in male and female plants concerned was examined, the testing method being similar to that described in the previous paper (10).



The results of the experiments showed in fact that the female is superior to the male in the content of reducing substances, thus if their quantity in the female is taken for 100, then that in the male is found less than 80 in the case of spinach and less than 90 in the case of *Ginkgo*. Hence the sexual distinctions clearly observed in the resistance to the toxicant is attributable to the differences in their relative quantity.

The formation of reducing substances noted above seems to have an intimate relation to the photosynthesis, so that it is better in the experiment to keep plants in the dark till they absorb chlorate and then expose them to the sun. This procedure was always taken out in treating plants, as previously explained.

It is interesting to note that the sexual differences are revealed in the quantity of reducing substances in plants. Their formation however, must be concerned with not only the photosynthesis but also the respiration and other physiological actions, hence the analysis of the whole problem along this line will need much more comprehensive study.

### Summary

1. In dioecious plants, such as spinach, hemp and *Ginkgo*, the resistance to the toxic action of chlorate was tested and compared between the sexes.

2. The males are found to be, as a rule, more resistant to the toxicant than the females.

3. The sexual distinction in the resistance to the toxicant is, as shown in the previous study, probably attributable to the difference in the content of reducing substances which convert the chlorate into hypochlorite very poisonous to plants.

---

## Literature cited

1. GRÜNBERG, O. An addition to the paper of Dr. MANOILOV'S "Identification of the sexes in dioecious plants by chemical reaction." *Bul. Appl. Bot. and Plantbreed.* **13** (2), 506. 1922-1923. (Cited in (5)).
2. MANOILOV, E. O. "Identification of the sexes in dioecious plants by chemical reaction." *Bul. Appl. Bot. and Plantbreed.* **13** (2), 503-505. 1922-1923. (Cited in (5)).
3. MANOILOV, E. O. Weitere Erfahrung über meine chemische Blutreaktion zur Geschlechtsbestimmung bei Menschen, Tieren und durch Chlorophyll bei Pflanzen. *Münchener medizinische Wochenschrift.* Nr. **51**, 1784-1789. 1924.
4. MINENKOV, A. Nautschno Agronomitscheskii Zurnal. *Jour. Sci. Agr.* Vol. **1**, 1924. (Cited in (5)).
5. SATINA, S. and DEMEREC, M. MANOILOV'S reaction for identification of the sexes. *Science*, Vol. **62**, No. **1601**, 225-226. 1925.
6. TADOKORO, T. and ABE, S. Studies on the enzyme chemistry of the sexes. *Jour. Agr. Chem. Soc. Japan*, Vol. **6**, 12-6, 1930. (In Japanese.)
7. TADOKORO, T. and ITO, K. Studies on the enzyme chemistry of the sexes. *Ibid.* Vol. **6**, 800-803. 1930.
8. ——— Studies on the enzyme chemistry of the sexes. *Ibid.* Vol. **7**, 171-174. 1930.
9. YAMASAKI, M. Testing of the resistance of varieties of certain crop plants to the toxic action of potassium chlorate with seeds and young seedlings. (Japanese with English résumé). *Jour. Imp. Agric. Exp. Sta.* Vol. **1**, 287-304. 1931.
10. ——— On the cause of varietal distinction in certain crop plants in regard to the resistance to the toxic action of potassium chlorate. (Japanese with English résumé). *Ibid.* Vol. **1**, 306-326. 1931.

---

*Remark by the editor.*—The work of Ph. JOYET-LAVERGNE (*La physico-chimie de la sexualité*. Berlin 1931) seems to be unknown to the author. This fact will however neither interfere with his experimental results nor impair the value of his paper.

---

# Interspecific hybridization in *Brassica* V

## The cytology of F<sub>1</sub> hybrid of *B. carinata* and *B. alboglabra*<sup>(1)</sup>

By Toshitaro MORINAGA

---

With plate XX and 14 text-figures

---

(Received March 26, 1933)

It was reported in my previous paper (6), that the F<sub>1</sub> hybrid of *B. carinata* ( $n = 17$ ) and *B. chinensis* ( $n = 10$ ) or *B. rapa* ( $n = 10$ ) contains in its microsporocytes a variable number of bivalent chromosomes. It was then assumed, chiefly from the consideration of the number of chromosomes, that *B. carinata* was constituted with two elemental sets of chromosomes or genomes. In this report, I will describe some karyological features observed in the microsporogenesis of an interspecific hybrid, *B. carinata*  $\times$  *B. alboglabra*, and want to take a step forward toward the complete understanding of the genomic constitution of *B. carinata*, as well as other *Brassica* species.

### Materials and methods

*The parental species:* Some descriptions were given in the former publications (6 and 7) of the one parental species *B. carinata* BRAUN. As to *B. alboglabra* BAILEY, the other parent, SIN SKAIA (8) says: "one of the Asiatic species *B. alboglabra* unexpectedly readily crosses with vegetable cabbage and closely approaches *B. oleracea* in all its characters, therefore it may be also included into the collective species *B. oleracea*." Both species *B. alboglabra* and *B. oleracea* possess the same number of chromosomes (1). The hybrid, *B. alboglabra*  $\times$  *B. oleracea* raised by me in 1931 showed in the next spring the complete fertility, performing the normal reduction divisions.

---

(1) Contributions from the Institute of Agronomy, Kyushu Imperial University, No. 48.

Fig. 1 and Fig. 2 represent respectively the heterotypic anaphases of the pollen mother-cells of *B. alboglabra* and its hybrid with *B. oleracea*.



Fig. 1. *B. alboglabra*. Heterotypic anaphase showing 2 groups of 9 disjoined halves of bivalents.  $\times 4000$ .

Fig. 2.  $F_1$  of *B. alboglabra*  $\times$  *B. oleracea*. Heterotypic anaphase showing 2 groups of 9 disjoined halves of bivalents.  $\times 4000$ .

*The  $F_1$  hybrid:* The hybrid, *B. carinata*  $\varnothing \times$  *B. alboglabra*  $\sigma$  was rather difficult to be achieved. In 1931, only one germinable seed was obtained from 36 emasculated *carinata* flowers artificially pollinated with the *alboglabra* pollen-grains. The reciprocal hybridization on 23 *alboglabra* flowers as  $\varnothing$  produced but a few non-viable seeds. Thus one  $F_1$  individual was raised in 1931, which provided the materials for the present studies. Some outstanding characters of *B. alboglabra*, *B. carinata* and their  $F_1$  plant are presented in Table I.

TABLE I. The outstanding characters of the  $F_1$  and its parental species (cf. Pl. XX)

Characters	<i>B. alboglabra</i>	<i>B. carinata</i>	$F_1$
Height of plant	dwarf	tall	dwarf
Colour of leaf	blue green	green	blue green
Margin of leaf	almost entire	lobed	lobed, intermediate
Colour of stem-node	green	purple	green
Time of anthesis	early	late	early, intermediate
Colour of petal	white	yellow	white
Sepals	erect, longer than the petal's claw	somewhat spreading, shorter than the claw	erect, intermediate in length
Inflorescence	normal cabbage type	pedicel short, erect with bract	pedicel short, fairly erect, often with bract



The hybrid which showed a striking heterosis in its branching habit, resulted in the plant of a typical bush form. It produced no seeds when the inflorescences were bagged, though some seeds were obtained by open pollination.

The anthers in the right stage of development were fixed with BENDA's or BOUIN's fixative. Sections 10–15  $\mu$  thick were made according to the paraffin method, and stained with iron-alum-haematoxylin.

### Results of karyological observations

*Heterotypic division:* As my attention was concentrated on the meta- and anaphases of the division, the present descriptions will almost be confined to those stages. The first fact that was ascertained in the heterotypic metaphase was the constancy of the total number of

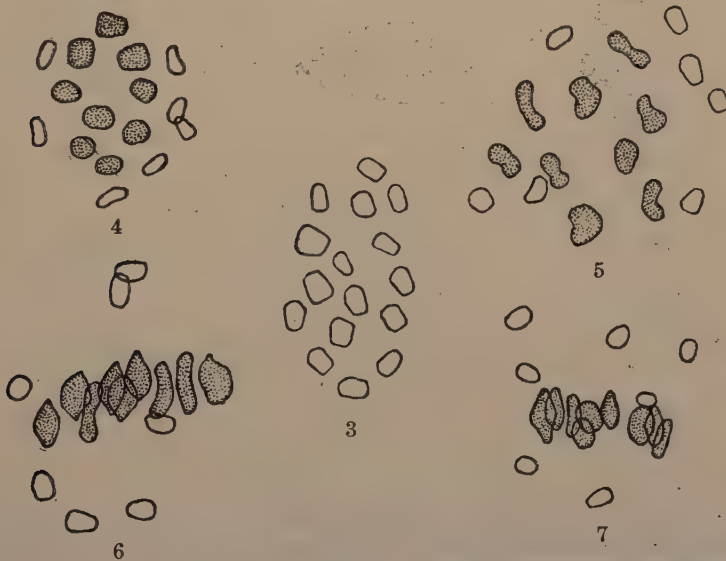


Fig. 3-7.  $F_1$  of *B. carinata*  $\times$  *B. alboglabra*. Heterotypic metaphase. Fig. 3. Polar view, all 16 chromosomes on the equatorial plate; on account of dark staining distinction of chromosome-valency is impossible. Fig. 4. Polar view, an example from well accomplished preparation,  $9_{II}$  and  $7_I$  are clearly indicated. Fig. 5. Oblique view, showing  $9_{II} + 7_I$ . Fig. 6 and 7. Side views, showing  $9_{II} + 7_I$ .  $\times 4000$ .

chromosomes. Sixteen chromosomes were counted in 222 pollen mother-cells, and no perfect mother-cells showed clearly any other than

16 chromosomes. Though often all of them are disposed on the equatorial plane (Fig. 3), more generally some of them remain freely distributed on the spindle (Fig. 4). In very well differentiated preparations, the univalents may be easily discriminated from the bivalents by their position, shape and size, and often by the depth of staining. Fig. 3 shows a polar view of a mother-cell with deeply stained chromosomes, 16 in number, on the equatorial plane. Though the cell wall suits for counting the total number of chromosomes, the distinction of the chromosome-valency is utterly impossible. In such a cell as depicted in Fig. 4, the position, shape and size of chromosomes enable us, when familiar with the material, to distinguish with sufficient accuracy the univalent chromosomes from the bivalent ones.



Fig. 8-10.  $F_1$  of *B. carinata*  $\times$  *B. alboglabra*. Heterotypic anaphase. Fig. 8. All bivalents having disjoined, 25 chromosomes are counted. Fig. 9. Polar view depicted at 2 different foci, upper (a), and lower (b) showing 7 intact univalents and 2 groups of disjoined bivalents. Fig. 10. Polar view depicted at 3 different foci, upper (a), middle (b), and lower (c) showing 7 intact univalents and 2 groups of disjoined bivalents.  $\times 4000$ .

In the profile views of the mother-cells, the univalents may be pointed out more easily than in the polar views, but the exact counting of the bivalents is usually more difficult as they lie one upon another (Fig. 6 and 7). In well differentiated metaphasic figures, 9 bivalents

and 7 univalents make always the total of 16 metaphasic chromosomes. This fact was ascertained by the subsidiary observations in the following anaphase. In the early heterotypic anaphase, all the bivalents disjoin almost simultaneously, leaving the univalents still intact, and the cell now contains in total 25 chromosomes (Fig. 8). Often the 7 univalents and the 2 groups of 9 disjoined halves can be pointed out easily, owing chiefly to the symmetrical position taken by the members of the latter 2 groups (Fig. 9 and 10). In this stage of division process, the univalents situated out of the equator seem to come to that region, encircling the space formerly occupied by the bivalents. In Fig. 10 and 11 such circular hollow plates of univalents in their polar and side views are represented respectively. The univalents split out soon and the halves follow the descendants of the bivalents. A cell in its interkinetic condition is shown in Fig. 12.

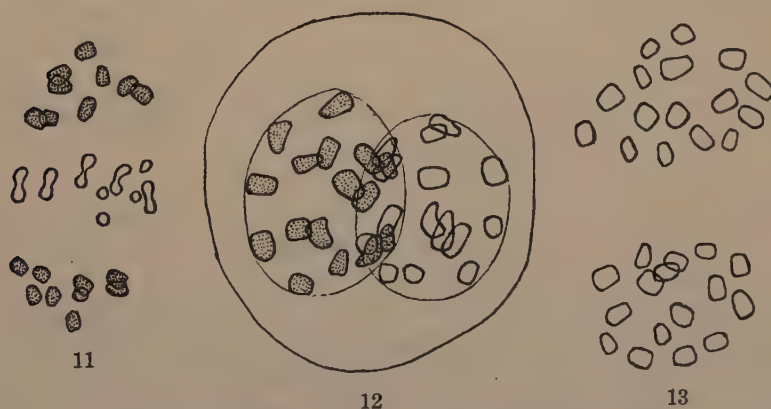


Fig. 11.  $F_1$  of *B. carinata*  $\times$  *B. alboglabra*. Heterotypic anaphase, 7 univalents at the equator going to split.  $\times 4000$ . Fig. 12.  $F_1$  of *B. carinata*  $\times$  *B. alboglabra*. A cell in interphase.  $\times 4000$ . Fig. 13.  $F_1$  of *B. carinata*  $\times$  *B. alboglabra*. Sister metaphasic plates of the homotypic division.  $\times 4000$ .

*Homotypic division:* In the homotypic metaphase, the chromosomes are disposed fairly regularly on the equatorial plate (Fig. 13). Though the total number of the plates specially examined was only 38, the results give us some idea on the frequency distribution of chromosomes in the homotypic spindles (Table II).

TABLE II. Frequency distribution of the number of chromosomes in homotypic metaphase

Number of chromosomes on the homotypic spindle	13	14	15	16	17	Average
Frequency	1	2	21	11	3	15.3

As the hybrid plant discloses 9 bivalents and 7 univalents in the heterotypic metaphase, 16 chromosomes should be contained in each homotypic spindle, if all of the univalents perfectly split in the heterotypic anaphase, and none of their halves are lost in the cytoplasm. Actually, however, only 29% of the homotypic spindles showed 16 chromosomes, and 15 chromosomes were counted in more than 55% of the spindles. These facts will be taken to mean the frequent loss of one half of an univalent, and the rare occurrence of 17 chromosomes perhaps indicates an occasional imperfect separation of an univalent in the heterotypic anaphase. In the homotypic anaphase many lagging chromosomes were observed, 6 or 7 being most frequent. Often some of the laggards were excluded out of the reforming nuclei, producing tiny extra microspores in addition to the principal ones.

### General remarks

As already mentioned *B. alboglabra* and *B. carinata* possess in haploid 9 and 17 chromosomes respectively. Their artificial hybrid presented the specific characters of both parents, leaving morphologically no doubt about its hybrid nature. The plant, nevertheless, showed consistently in the heterotypic metaphase 16 chromosomes consisting of 9 bivalents and 7 univalents. Thus, though the counting of the somatic chromosomes was not successful, the zygotic number of chromosomes of this hybrid plant was taken as 25 instead of 26 which is the sum of the both gametic numbers. Leaving off the speculation how this has happened, perhaps this deferment will not affect essentially the following discussions, and I shall consider two chief problems: The mode of bivalent formation in the present hybrid, and the kind of the elemental chromosome sets or genomes constituting the parental species.



As the hybrid, *B. alboglabra*  $\times$  *B. oleracea* shows constantly 9 bivalents in the microsporocyte, *B. alboglabra* is taken as a monogenomic species having a similar set of chromosomes as found in *B. oleracea*. *B. carinata*, on the contrary, was supposed to be a digenomic species (6). Is there any possibility for the *carinata* chromosomes to undergo synapsis *inter se* in the  $F_1$  microsporocyte, if dissimilar genome only is contributed by the other parent? The



Fig. 14.  $F_1$  of *B. alboglabra*  $\times$  *Raphanus sativus*. Heterotypic metaphase, showing  $22I+2II$ .  $\times 4000$ .

$F_1$  hybrid, *B. carinata*  $\times$  *Raphanus* gives us sufficient information in this connection. Generally speaking such a *carinata*-*Raphanus* hybrid produces no constant bivalents in the microsporogenesis, the fact indicating neither constant affinity between *Raphanus*- and *carinata*-chromosomes, nor conceivable homology between *carinata*-chromosomes themselves. Fig. 14 represents a pollen mother-cell of the *carinata*-*Raphanus* hybrid containing 22 univalent chromosomes, and 2 occasional bivalent ones. Thus for the 9 constant bivalents found in the microsporocyte of *B. carinata*  $\times$  *B. alboglabra*, the only explanation reserved is the allosynapsis, namely the conjugation of 9

*alboglabra*-chromosomes with 9 *carinata* ones. On this ground I conclude that one of the two constructive chromosome sets of *carinata* is identical to the set which constitutes *B. alboglabra* or *B. oleracea*. KARPECHENKO (2) observed at least 9 bivalents in the hybrid of *Raphanobrassica* (tetraploid) and *B. carinata*, which in my opinion, were produced allosynaptically between the *oleracea* set in *Raphanobrassica* and the set here identified in *B. carinata*.

In my former publications (3 and 5), I analysed the chromosome complement of *B. Napella* into 2 elemental sets a and c of 10 and 9 chromosomes respectively<sup>(1)</sup>. Since then some workers seem to hold the idea that the 9 chromosome set in *Napella* might be identical to the *oleracea* set. This problem will be discussed on another occasion on the basis of actual karyological observations.

As one set in *carinata* comprises 9 chromosomes, the other set will embrace the remaining 8 chromosomes, perhaps one of which

(1) Formerly the 9 chromosome set was denoted with c'.

was lost by chance in the hybrid now investigated. The problem whether this 8 chromosome set is identical to the 8 chromosome set b (5) found in *B. juncea* and *B. cernua*, or to the set of *B. nigra* ( $n = 8$ ) is another important problem which should be solved on the actual karyological basis.

So far as the foregoing presumptions hold, *B. carinata* does not contain the set a (5) of *B. chinensis* or other allied species. Then for a varying number of bivalents observed in the  $F_1$  of *B. chinensis*  $\times$  *B. carinata* some special explanation is needed. Here I can not overlook the fact that the bivalents observed in the *chinensis*-*carinata*, and *carinata*-*Raphanus* hybrids take more elongated form along the spindle axis than the bivalents found in the species hybrid assumed to embrace two identical sets of chromosomes.

Strictly speaking, the *carinata*-*alboglabra* hybrid also belongs to the *Pilosella*-type in the *Drosera* scheme. It approximates, however, very much to the *Triticum*-type represented by the pentaploid *Triticum* hybrid.

The expense of this investigation was generously granted by the Imperial Academy.

PLANT-BREEDING LABORATORY,  
KYUSHU IMPERIAL UNIVERSITY.

---

## Literature cited

1. KARPECHENKO, G. D., 1928. Polyploid hybrids of *Raphanus sativus* L.  $\times$  *Brassica oleracea* L. Zeitschr. indukt. Abst.-Vererb.-Lehre **48**: 1-85.
2. ———, 1929. A contribution to the synthesis of a constant hybrid of three species. Proc. U.S.S.R. Congress of Genet. Plant- and Animal-Breeding **2**: 277-294.
3. MORINAGA, T., 1929. Interspecific hybridization in *Brassica* I. The cytology of  $F_1$  hybrids of *B. Napella* and various other species with 10 chromosomes. Cytologia **1**: 16-27.
4. ———, 1929. Interspecific hybridization in *Brassica* II. The cytology of  $F_1$  hybrids of *B. cernua* and various other species with 10 chromosomes. Jap. Jour. Bot. **4**: 277-289.
5. ———, 1929. Interspecific hybridization in *Brassica* III. The cytology of  $F_1$  hybrid of *B. cernua* and *B. Napella*. Jour. Dep. Agr. Kyushu Imp. Univ. **2**: 199-206.
6. ———, 1931. Interspecific hybridization in *Brassica* IV. The cytology of  $F_1$  hybrids of *B. carinata* and some other species with 10 chromosomes. Cytologia **3**: 77-83.
7. MORINAGA, T. and E. FUKUSHIMA, 1930. Another new chromosome number in *Brassica*. Bot. Mag., Tokyo **44**: 373-374.
8. SINSKAIA, E. N., 1927. Geno-systematical investigations of cultivated *Brassica*. Bull. Appl. Bot. and Plant-Breeding **17**: 1-166.

## Explanation of plate XX

- Fig. 1. The  $F_1$  hybrid of *B. carinata*  $\times$  *B. alboglabra*, producing the flowering stalk.
- Fig. 2. The  $F_1$  hybrid of *B. carinata*  $\times$  *B. alboglabra*, in bloom.
- Fig. 3. a. The inflorescence of *B. alboglabra*.  
b. The inflorescence of *B. carinata*.  
c. The inflorescence of the  $F_1$  hybrid of *B. carinata*  $\times$  *B. alboglabra*.







1



2



b

c

a

3



# A contribution to the knowledge of parasitism of *Valsa Paulowniae*, in relation to temperature

By Kogo TOGASHI and Kanae UCHIMURA

---

With 4 text-figures

---

(Received April 28, 1933)

## Introduction

Comparatively few researches of temperature effects on the growth of *Valsa* species have been published. In the previous papers the senior author (1924, 1930, 1931) reported the cardinal temperatures of *V. Mali* MIYABE et YAMADA for its growth in culture, and also that of *V. japonica* MIYABE et HEMMI and *Leucostoma Persoonii* (NITSCH.) TOGASHI (*V. leucostoma* (PERS.) FR.) for their growth, in connection with these, considering the parasitism in the case of canker or die-back disease of peach trees caused by the fungi. SCHREINER (1931) is another investigator on this subject studying the growth rate of *V. sordida* NITSCH. and *V. nivea* (HOFF.) FR.

The present paper deals with certain considerations of the parasitism of *V. Paulowniae* MIYABE et HEMMI based on the temperature requirement of this fungus for its mycelial growth and the temperature fluctuations of *Paulownia tomentosa* under natural conditions.

## Mycelial growth at various temperatures

### *Experiment I*

For the purpose of this study the plate culture method with PETRI dishes was used. The increment in the diameter of mycelial mats was measured daily on three different culture media kept at the desired temperature and two or more plates a lot were averaged. The culture media and temperature set in incubators were as follows:—





TABLE 3

Daily growth on *V. Paulowniae* in paulownia decoction agar at various temperatures. (Diameter of mycelial mats in cm.)

Temp. Days	12	15	18	21	24	27	30	33
1	0	0	Visible	Visible	1.0	1.2	Visible	0
2	Visible	Visible	1.7	1.6	2.5	2.9	2.0	0
3	1.0	1.0	3.0	2.8	4.1	4.9	2.8	0
4	1.6	1.5	3.9	3.8	5.5	6.5	3.2	0
5	2.4	2.3	5.1	5.4	7.2	8.3	3.4	0
6	3.2	3.2	6.1	6.2	8.0	8.8	3.5	0
7	4.1	4.1	6.5	6.8	8.4	8.8	3.5	0
14	8.2	8.2	8.4	8.8	8.8	8.8	3.7	0

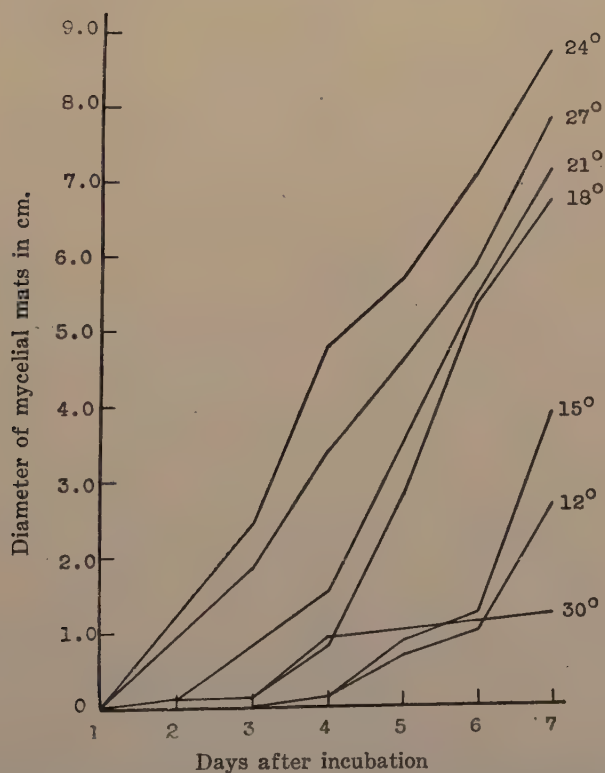


Fig. 1. Daily growth of *V. Paulowniae* in oat meal agar at various temperatures.

In all the three culture media employed the fungus under consideration was able to grow at temperatures ranging from 12°C. to 30°C., but at 33°C. there was no visible growth during the entire period of 14 days. At 12° and 15°C. the visible growth took place within 2 or 4 days and the subsequent growth was fairly rapid, often producing aerial mycelium over the edge of PETRI dishes (the “+” sign in the tables denotes this condition). At 30°C. the fungus started to grow one or two days after inoculation but the growth was then slow, measuring only 3.1 cm. in the media of potato dextrose and oat meal, and 3.7 cm. in the medium of paulownia decoction

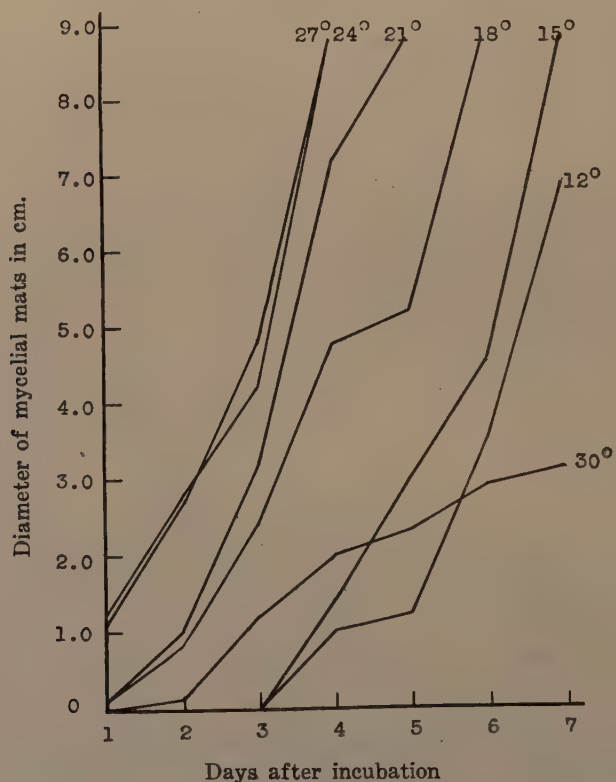


Fig. 2. Daily growth of *V. Paulowniae* in potato dextrose agar at various temperatures.

at the end of this experiment. It is of interest to note that the cultures at 12°C. which started to grow one or two days later showed more vigorous subsequent growth than those at 30°C. Thus, it may

be said that without fail the fungus could thrive well under conditions of relatively low temperatures, although the favorable temperature for its growth was found to be from 18° to 27°C. with an optimum of 24°–27°C.

Out of the three media used potato dextrose agar seemed to be best for the fungous growth. In all cases, however, the aerial mycelium developed vigorously at lower temperatures and the creeping mycelium was prominent at higher temperatures. As the cultures

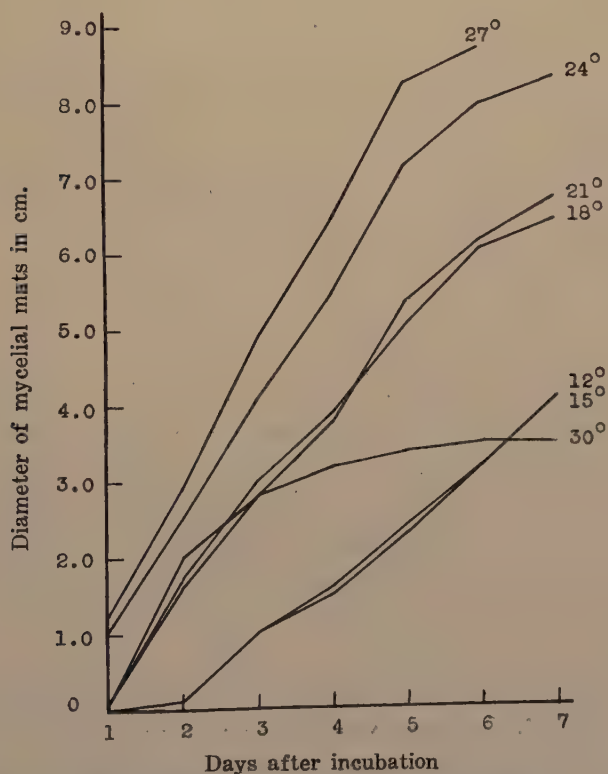


Fig. 3. Daily growth of *V. Paulowniae* in paulownia decoction agar at various temperatures.

aged the aerial mycelium showed light pinkish cinnamon and the creeping mycelium from vinaceous-buff to avellaneous color. At the optimum temperature two or three zonations were also observed.

### *Experiment II*

In this experiment the temperature secured in incubators was varied at 5° intervals from 5° to 35°C. The medium used was corn meal agar poured in PETRI dishes. Table 4 and figure 4 show the average daily increment of mycelial mats in the plate agar.

At 5°C. there was visible growth on the 6th day after incubation and the growth measured 2.2 cm. in diameter on the 14th day. At 10°C. the growth started on the 3rd day and then went in proper sequence. No growth occurred at 35°C. At 30°C. visible growth was observed on the 3rd day but the mycelium grown staled and disappeared on the 5th day. The most vigorous growth took place at 25°C.

In general, the growth in this medium seemed to be poorer than in any of the media used in Experiment I and the fungus had a tendency to develop as creeping mycelium, not as aerial.

### *Experiment III*

This experiment consists of two series with solution culture. In the first series temperatures taken were 5°, 10°, 15°, 20°, 25° and 30°C., and in the second 7°, 12°, 17°, 22°, 27° and 32°C. Fifty cc. of potato dextrose (1%) decoction were placed in each of ERLÉNMEYER's flasks of 150 cc. capacity, and they were inoculated and incubated. After the desired incubation, the dry weight of mycelium was measured in milligrammes and averaged for two or three flasks. The results are shown in Table 5.

At 25°C. visible growth occurred one day after incubation, at 15°, 20°, 22°, and 27°C., 2 days after, and at 5° and 7°C., 6 days after. There was no growth at 30° and 32°C. even 30 days later. The most vigorous growth took place at 25°C. in the first series and at 22°C. in the second. It is noticeable that in the solid medium of potato dextrose agar as in the case of paulownia decoction agar the best growth occurred at 27°C. while in the nutrient solution of potato dextrose the growth was best at 22°C. among the temperatures at which the fungus was incubated, including 27°C.



TABLE 4

Daily growth of *V. Paulowniae* in corn meal agar at various temperatures. (Diameter of mycelial mats in cm.)

Temp. C. Days	5	10	15	20	25	30	35
1	0	0	0	Visible	Visible	0	0
2	0	0	Visible	0.8	1.8	0	0
3	0	Visible	1.0	1.5	3.6	Visible	0
4	0	0.8	1.7	3.0	4.5	Visible	0
5	0	1.2	2.5	4.3	6.5	0	0
6	Visible	1.6	3.7	5.1	8.2	0	0
7	Visible	2.0	4.0	6.2	8.8	0	0
14	2.2	5.7	8.8	8.8	8.8	0	0

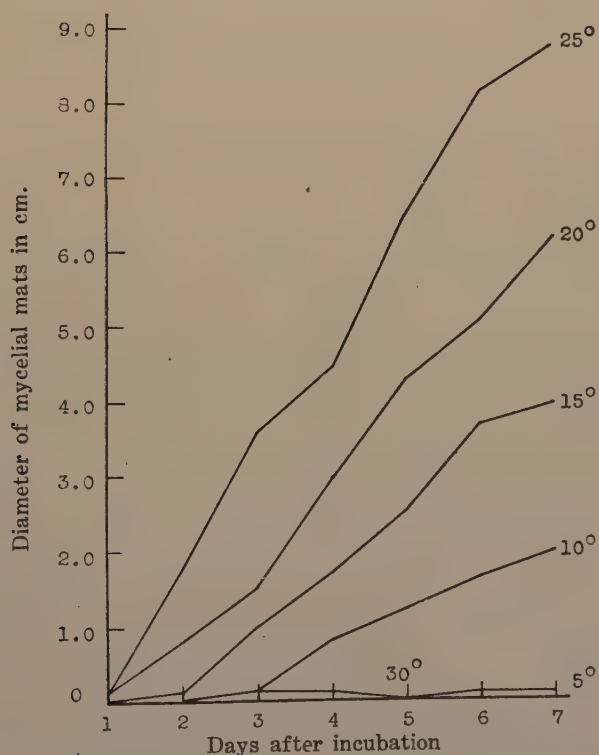


Fig. 4. Daily growth of *V. Paulowniae* in corn meal agar at various temperatures.

TABLE 5

Dry weight of the mycelium of *V. Paulowniae* grown in potato dextrose decoction at various temperatures. (in miligramme)

Temp. C.	5	10	15	20	25	30	7	12	17	22	27	32
Days												
1					vg*							
2			vg	vg						vg	vg	
3								vg	vg			
4		vg										
6	vg						vg					
12	12	21	27	22	64	0	13	26	27	44	10	0
20	19	46	49	50	102	0		60	75	98	43	0
30	33	51	97	90	157	0	27	73	100	135	126	0

\* vg denotes visible growth.

### Considerations of parasitism

The senior author (1924) found that the optimum temperature for the growth of *V. Mali* is 23–32°C., the maximum temperature about 37–38°C. and the minimum somewhere between 3° and 10°C. The same author (1930) in his comparative study on two fungi causing peach canker stated that *L. Persoonii* can grow within a wide temperature range of 5–39°C. with a favorable temperature of 23–32°C., while the best growth of *V. japonica* takes place at 23–25°C. with narrow range of critical temperatures at 5° and 32°C. According to SCHREINER (1931) who studied the growth rate of *V. sordida* and *V. nivea* at temperatures of 4°, 9°, 25°, and 35°C., the growth of the former fungus was most rapid at 25°C. but very slow at 4°C. At 35°C. one clon of the fungus showed a fairly rapid growth and the other a poor growth. In *V. nivea*, however, there was no growth at 4° and 35°C. during the entire period of 14 days. At 9°C. no measurable growth occurred until the 8th day and then the growth was very slow. The growth of this fungus was also best at 25°C. but it was considerably slower than that of *V. sordida*.

The fungus under consideration seems to start growing below 5°C. and the maximum temperature for its growth is seen to lie between 30° and 32°C. The best growth occurs at temperatures varying from 22° to 27°C. These characteristics of temperature require-

ment for growth correspond well with those of *V. japonica*, except that our fungus is able to grow at a lower temperature than *V. japonica*, presuming from the growth at 5°C. At temperatures higher than the optimum, growth increment of our fungus decreases promptly, soon after reaching the maximum temperature, that is to say, the temperature range between the optimum and the maximum is very narrow. Such a tendency of growth may be seen in all species of *Valsa* and *Leucostoma* cited above as well as in other cases of fungi, but it may be said to be more conspicuous in our case. Another interesting tendency is that not only the temperature range from the minimum to the optimum is evidently wide, but the growth at lower temperatures, at least at temperatures above 10°C., becomes good with age. These facts indicate that *V. Paulowniae* is a low temperature loving fungus as also *V. japonica*, but not like *V. Mali* and *L. Persoonii* which thrive well at comparatively high temperatures.

In his study of peach canker the senior author (1931) reported the temperature fluctuations in the paulownia trunk on its north-east side, recording them through a year and comparing them with that in the peach branch. The essentials of the records will be stated here for the sake of understanding the parasitism of *V. Paulowniae*, in connection with temperature. As a rule the temperature of paulownia tree fluctuates to a smaller extent and the disparity of tree- and air-temperatures is also smaller under direct sunlight than those observed in the peach branch, but varying some degrees with weather conditions. On fine days the maximum and minimum temperatures of the tree are respectively 4° or 5°C. below and 3° or 4°C. above those of the air. But on rainy, snowy or cloudy days the minimum temperature of the trunk is often 1° or 2°C. lower than that of the surrounding air. It is noteworthy that the tree temperature fluctuates below the zero point on almost all days during the period from January to the first ten days of February figuring a flat temperature curve and the minimum temperature does not fall so low as in the case of peach tree or of the air, and also that the tree temperature in April to May including the foliation period of the tree, in turn, fluctuates more widely than in the other months.

Referring to the two pieces of evidences mentioned above, namely the temperature requirement for the growth of the causal fungus and the temperature fluctuations of the host tree through a whole year, we may conclude that the causal fungus is highly adapted to

spend a parasitic life in the host tissues, because even in the hottest days of the year the maximum temperature of the paulownia tree is usually below the maximum temperature of the fungus growth and this is true at least on the north-east side of the trunk. Furthermore, the evidence that the minimum temperature of paulownia tree in cold days shows far above that of the air with narrow fluctuations demonstrates that the fungus may lie dormant in these days without any menace from the coldness.

The fungus distributes and causes serious die-back disease of paulownia trees in the northern part of Honshu and in Hokkaido (HEMMI, 1916-a, -b). If we take into consideration the temperature fluctuation of the host tree together with the temperature requirement of the causal fungus we may readily know that the fungus may be able to distribute far to warmer districts of Honshu although we can not deny that the climate in the northern parts is more favorable for its growth. There is one proof for this assumption in that the fungus was recently collected by Prof. T. WATANABE in the College Yard of Utsunomiya. Its occurrence is also reported by S. MATSUSHIMA (1932) in a list of parasitic fungi collected in the Utsunomiya Imperial College of Agriculture and Forestry.

### Summary

1. According to the writer's experiments which were undertaken under various conditions the minimum, optimum and maximum temperatures for the mycelial growth seem to be below 5°, 22–27°, and 30–32°C., respectively. These cardinal temperatures correspond well to those of *V. japonica* but not to those of *V. Mali* and *L. Persoonii* which grow vigorously at higher temperatures.

2. The fungus under consideration has a tendency to show a gradual growth at low temperatures as cultures age, in contrast with the impoverishment of growth increment at high temperatures with days. Consequently it is highly reasonable to say that the fungus is a low temperature loving one.

3. The temperature fluctuations of paulownia trunk are summarized in "Consideration of parasitism" in the present paper and detailed in a previous paper (1931). Considering the cardinal tem-



peratures for the growth of the fungus and then the temperature fluctuations of paulownia tree it is evident that the fungus is highly adapted to spend a parasitic life in the paulownia tissue in the northern districts of our country. However, it is also probable that the fungus may distribute, to a certain extent, in the districts of milder climate.

---

### Literature Cited

- HEMMI, T. (1916-a). On the die-back disease of *Paulownia tomentosa* caused by a new species of *Valsa*. Bot. Mag. Tokyo **30**, 304-315, 4 figs.
- (1916-b). On the die-back disease of paulownia trees. Transact. Sapporo Nat. Hist. Soc. **6**, 133-158, 4 figs. (in Japanese).
- MATSUSHIMA, S. (1932). A list of parasitic fungi collected in our college. Bul. Agric. Research Assoc., Utsunomiya Imp. Coll. Agric. & Forestry, No. **7**, Reprint 8 pp.
- SCHREINER, E. J. (1931). Two species of *Valsa* causing disease in *Populus*. Amer. Journ. Bot. **18**, 1-29, 5 pls., 1 fig.
- TOGASHI, K. (1924). Some studies on a Japanese apple canker and its causal fungus, *Valsa Mali*. Journ. Coll. Agric., Hokkaido Imp. Univ. **12**, pt. 3, 265-324, 4 pls.
- (1930). Comparative studies on the physiology of *Leucostoma leucostoma* and *Valsa japonica*. Bul. Imp. Coll. Agric. & Forestry, Morioka, No. **15**, 1-76, 1 pl., 3 figs.
- (1931). Studies on the pathology of peach canker. Bul. Imp. Coll. Agric. & Forestry, Morioka, No. **16**, 1-178, 2 pls., 34 figs.
-



# Cyto-genetical studies on the wild and cultivated Manchurian soy beans (*Glycine* L.)

By Yasona FUKUDA

With plates XXI-XXII and 7 text-figures

(Received June 13, 1933)

SECTIONAL TOPICS	
	Page
I. Introduction . . . . .	489
II. Material and methods. . . . .	492
III. Number and morphology of chromosomes . . . . .	493
IV. Development of the pollen grains . . . . .	496
V. Weight of seeds of the <i>Glycine</i> species . . . . .	498
VI. Genetical difference among the <i>Glycine</i> species . . . . .	501
VII. Origin of the soy beans . . . . .	503
VIII. Summary . . . . .	504
IX. Literature cited . . . . .	505
X. Explanation of plates XXI-XXII . . . . .	506

## I. Introduction

All the varieties of the wild and cultivated soy beans of Manchuria which are treated in this paper belong to one of the following three species (Fig. 1) :

1. *Glycine hispida* MAX. (*Glycine Soja* BENTH.). The characteristic feature of the plants belonging to this species is the rough stout stem and the large leaves, pods and seeds. All the Japanese and many of the Manchurian cultivated varieties belong to this species. The chromosome number of this species is 20 in haploid and 40 in diploid (KARPETSCHENKO; KAWAKAMI).

2. *Glycine gracilis* SKVORTZOW. (SKVORTZOW, 1927). The characteristic feature of the plants belonging to this species is intermediate between *Glycine hispida* and *Glycine Soja*. The seeds of the plants belonging to this species have usually been found accidentally mixed with Manchurian Mung beans. SKOVORTZOW in picking out

these seeds from the market Mung beans maintained that they belong to a distinctly new species, midway between *Glycine hispida* and *Glycine Soja*. The chromosome number of this species is unknown.

3. *Glycine Soja* S. et Z. (*Glycine ussuriensis* REGEL et MAACK.). The characteristic feature of the plants belonging to this species is the delicate twining stem and the small pods and seeds. SIEBOLD and ZUCCARINI (1845) gave the name of *Glycine Soja* to a wild variety of the soy bean of Japan, and REGEL and MAACK. (1861) the name of *Glycine ussuriensis* to a wild soy bean found in the Ussuri district, but they are the same. This species is the only representative of the *Glycine* L. family, growing wild in Manchuria. The chromosome number is unknown.

As regards the origin of the soy bean, ENGLER (1894) considered *Glycine Soja* S. et Z. in Japan and in Amurland to be a wild form of soy beans, *Glycine Soja* BENTH. or *Glycine hispida* MAXIM. This view was confirmed when SKVORTZOW (1927) discovered *Glycine gracilis*, an intermediate species of *Glycine hispida* MAX. and *Glycine Soja* S. et Z.

Both cytological and genetical investigations should also be made to determine the relationship among the *Glycine* species. At the Rikuu (Oou) Branch of the Agricultural Exp. St. of the Government of Japan, Sadao NAKATOMI and his assistant, Tominosuke NIBE, have undertaken crossing experiments of *Glycine Soja* S. et Z. and *Glycine hispida* MAX. When the present writer visited this branch station in the summer of 1920, he saw numerous descendants of hybrids of the genus *Glycine*, and it was observed that any  $F_1$ ,  $F_2$ ,  $F_3$  or  $F_4$  individuals or even those of crossings made back to the cultivated varieties presented the intermediate appearance of two parental species but no sign of segregation of the type of *Glycine hispida*. The result of this investigation of NAKATOMI and NIBE has not yet been published.

The present investigation was undertaken to obtain further details concerning the reproduction of plants belonging to the genus *Glycine* and to determine the nature of the karyological relationship among *Glycine* species.

The author takes this opportunity to express his gratitude to Professor Kiichi MIYAKE of the Tokyo Imperial University for the kind criticism and advice given on the occasion of his visit to the laboratory of the author in September of 1932.





Fig. 1. (1) *Glycine hispida* MAX. (Huang-pao-chu).  
 (2) and (3) *Glycine gracilis* SKVORTZOW.  
 (2) Do. The line with large seeds.  
 (3) Do. The line with small seeds.  
 (4) *Glycine Soja* S. et Z.

## II. Material and methods

This investigation was undertaken in 1928 after the author's visit to Skvortzow from which place the seeds of soy beans gathered

TABLE 1. Wild and cultivated Manchurian soy beans used in this investigation.

Species	Name of variety	Weight of seed in centigram. (Average of 100 grains)
<i>Glycine hispida</i> MAX.	An-kua 鞍掛	28.3
	Chu-ien-tou 猪眼豆	26.6
	Li-uai-ching-tou 裏外青豆	25.2
	Huang-pao-chu (1927)	21.6
	Do. (1928) 黃寶珠	21.4
	Do. (1932)	21.4
	Chang-chun-hung-tou 長春紅豆	16.1
	Fu-chin-üan 福金元	15.7
	Chien-chia-ching-tou 錢夾青豆	15.3
	Kung-chu-ling (round black seed) 公主嶺丸形黑實	14.5
	Kung-chu-ling No. 982	12.2
	Chu-liang-tou 株良立	8.4
<i>Glycine gracilis</i> SKVORTZOW	Line of large seeds.	7.2
	Common	4.8
	Line of small seeds.	3.5
	Kung-chu-ling No. 505	4.5
	Kung-chu-ling No. 504	4.3
	Kung-chu-ling No. 502	3.9
	Kung-chu-ling No. 503	3.8
<i>Glycine Soja</i> S. et Z.	Wild in woods near Mukden (1929)	1.7
	Cultivated for cattle food at Kung-chu-ling SMR Ex. St.	1.6
	Wild in mountain regions	1.4
	Wild in fields	1.3
	Wild on the bank of the River Sungari (1928)	0.8

from the individual plants planted in the course of his original investigation were supplied. Seeds of some other varieties were supplied through the courtesy of Dr. NAKAMOTO of the Agricultural Exp. St. of S. M. R. Co. at Kungchu-ling in Manchuria. The varieties used in this experiment were classified according to the size of the seeds of plants belonging to them (Table 1).

Naked young anthers were killed in FLEMMING's solution for the observation of reproductive cells, and root tips for that of somatic cells. FLEMMING's strong solution without adding acetic acid but treated with aceto-picric solution has often given a more satisfactory result for fixation. The young anthers of *Glycine hispida* were first fixed at the end of June, then those of *G. gracilis* and finally those of *G. Soja* in the early part of July. Sections were cut from 8 to 12  $\mu$  in thickness. HEIDENHAIN's iron-alum-haematoxylin was used for staining them.

### III. Number and morphology of chromosomes

The number of chromosomes of *Glycine hispida* has been reported by KARPETSCHENKO (1925) as 40 in diploid, by YAMAHA and SINOTÔ (1925) as 38 in diploid and by KAWAKAMI (1930) as 40 in diploid and 20 in haploid. KAWAKAMI (1930) using BELLING's iron-aceto-carmine method, found in respect of 35 horticultural varieties that the haploid number of chromosome of these varieties is 20. Therefore the diploid number of their chromosomes was expected to be 40 and this was proved to be the case in respect to somatic cells of two of these varieties. Although one of these varieties is mentioned in the list of varieties he examined as wild plants, and various names of cultivated plants found in Japan and Korea are given to the remaining 34 varieties, all these plants are designated as horticultural varieties of *Glycine hispida* MAX.

The author counted 40 chromosomes in the metaphase of somatic nuclear division in the root tips, and 20 chromosomes in the metaphase or anaphase of heterotypic nuclear division of pollen mother cells (Fig. 3; Pl. XXI, fig. 7) in respect to the eight Manchuria varieties described in Table 1. The counting of the chromosomes in *Glycine gracilis* and *Glycine Soja* S. et Z. showed also that the somatic number is 40 and the haploid number 20 (Fig. 4 and 5; Pl. XXI, fig. 6). The study of two intermediate varieties of *Glycine hispida* and

*Glycine gracilis*, and four intermediate varieties of *Glycine gracilis* and *Glycine Soja* (Table 1), also confirmed this.

The somatic chromosomes of the *Glycine* species are rod-shaped, and the chromosomes in the meta- and anaphase of the pollen mother

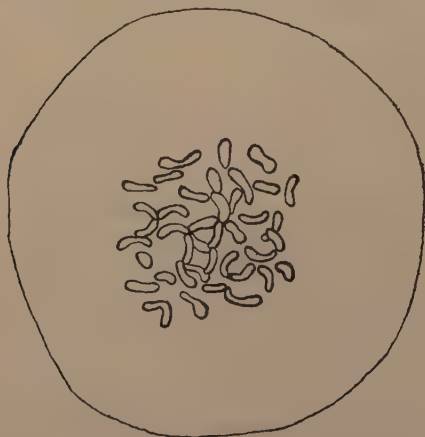


Fig. 2. Metaphase. Polar view of the nuclear plate in a somatic cell showing 40 chromosomes. *Glycine gracilis* SKVORTZOW.  $\times 2000$ .

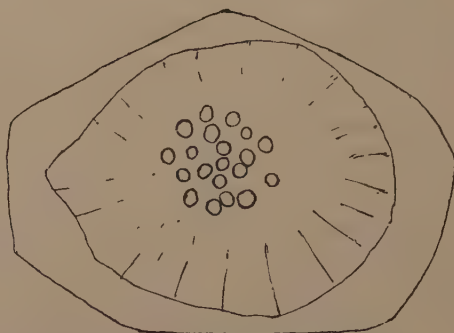


Fig. 3. Anaphase. Polar view of a daughter nuclear plate of the heterotypic division showing 20 chromosomes. *Glycine hispida* MAX. (Huang-pao-chu).  $\times 2000$ .

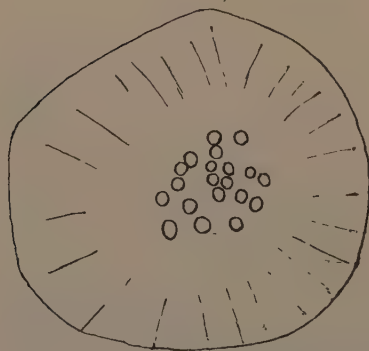


Fig. 4. Do. (*Glycine Soja* S. et Z.)  $\times 2000$ .

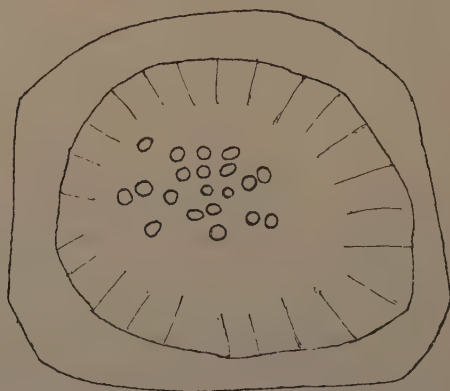


Fig. 5. Do. Metaphase. (*Glycine gracilis* SKVORTZOW.  $\times 2000$ .

cells are spherical. As the latter chromosomes were stained distinctly they were used for the comparison of the size of chromosomes of



different species. The polar views of four nuclear plates of metaphase were drawn by the aid of camera lucida, and the diameter of the figures of chromosomes was measured by micrometer. The four records of the chromosomes are averaged in the same order and given in the following Table 2.

TABLE 2. Diameters of the chromosomes of *Glycine* species.

No. of chromosomes arranged by the order of diameter	<i>G. hispida</i> MAX.		<i>G. gracilis</i> SK.		<i>G. Soja</i> S. et Z.	
	Records of micro-meter	in $\mu$	Records of micro-meter	in $\mu$	Records of micro-meter	in $\mu$
1	83	1.038	83	1.038	80	1.000
2	80	1.000	75	0.904	80	1.000
3	75	0.904	75	0.904	75	0.904
4	73	0.901	70	0.875	73	0.901
5	72	0.900	70	0.875	70	0.875
6	68	0.850	70	0.875	70	0.875
7	65	0.813	68	0.850	65	0.813
8	65	0.813	65	0.813	63	0.790
9	65	0.813	65	0.813	63	0.790
10	63	0.790	63	0.790	63	0.790
11	63	0.790	63	0.790	60	0.750
12	60	0.750	60	0.750	60	0.750
13	60	0.750	60	0.750	60	0.750
14	58	0.730	60	0.750	60	0.750
15	58	0.730	60	0.750	58	0.730
16	57	0.710	58	0.730	58	0.730
17	53	0.663	55	0.688	55	0.688
18	53	0.663	55	0.688	55	0.688
19	52	0.650	50	0.625	53	0.663
20	52	0.650	50	0.625	53	0.650
Total sum	1275	15.938	1275	15.938	1274	15.925
Average		0.797		0.797		0.796

This table shows that among the *Glycine* species there is no great difference in the size of the chromosomes, and it may therefore be assumed that not only the number of chromosomes but also the size of the chromosomes among the *Glycine* species is similar.

#### IV. Development of the pollen grains

Observations were made to see whether there are any cytological differences among the varieties of soy beans, but these varieties show no consistent differences and all the data presented will therefore be applicable to either species of *Glycine*. A short sketch of these processes may be given.

*Development of the anther.*—The developing anther-wall consists as in other species of an epidermal layer, two middle layers and a layer of tapetum (Pl. XXI, fig. 1). The primary sporogenous cells divide a few times and produce a few columns of pollen mother cells. Though the tapetum differentiates rather early, its cells remain uninucleate (Pl. XXII, fig. 11).

*Heterotypic nuclear division.*—When the pollen mother cells enter the prophase of the first meiotic division their protoplasts are angular and are pressed together (Pl. XXI, fig. 1 and 2). No variation is found in the stages of development of the pollen mother cells in the different loculi of the same anther. The cytoplasm becomes dense and stains darkly (Pl. XXI, fig. 2). A delicate network of chromatin threads occupies all of the nuclear cavity except that part immediately around the nucleolus. While thickening in the threads is in progress the entire network contracts and often draws to one side of the nucleus, until the chromatin material forms a thready ball. The nuclear cavity enters upon a period of enlargement which continues until after synizesis. The size of the nuclei found in stages later than synizesis (Pl. XXI, fig. 3) has a diameter of almost twice that of cells in the early synizetic stages (Pl. XXI, fig. 2). The thread thickens and forms a large loop as it begins its passage out of synizesis (Pl. XXI, fig. 3). The loculus of the anther enlarges during synizesis, and the protoplast separates from the original cell wall at the angles and begins to round up (Pl. XXI, fig. 3). The space left by the withdrawal of the protoplast becomes filled with a homogeneous substance as described by REEVES (1930) in respect to alfalfa.

On the prophasic process of the heterotypic division of *Glycine hispida*, INOUE (1929) conducted a study on the connection which the nucleolus has with the spireme and found that the spireme is connected with the nucleolus at the point of conjugation between the nucleolus and the secondary nucleolus, and some threads of the

spireme, especially those connected with the nucleolus containing much chromatin, are dark. This the present author confirms. A network occupying most of the enlarged nuclear cavity is now formed by the bivalent thread (Pl. XXI, fig. 4) and the chromatin material loses some of its affinity for stains and thus they enter the achromatic strepsitene stage (INOUE, 1929-1932). After the process of segmentation of the spireme thread, pairs of dark-staining bodies are seen to be twenty in number, which is comparable to the haploid number of chromosome, determined in later stages. The chromosomes then take in the nucleus a position which is characteristic of diakinesis, and the numbers of a pair are loosely associated (Pl. XXI, fig. 5) and their bivalent nature is easily determined. The limits of the nucleus disappear, and after a multipolar spindle stage a typical bipolar spindle is formed (Pl. XXI, fig. 6).

The 20 bivalent chromosomes are separated into univalent chromosomes in the nuclear plate (Pl. XXI, fig. 6 and 7). Each univalent daughter chromosomes regularly pass to the poles. The univalent chromosomes show no sign of splitting at this time. The daughter nuclei undergo a complete reorganization at the end of the heterotypic division. Extranuclear nucleoli appear. Typical interkinesis is visible (Pl. XXII, fig. 8). At the earliest interkinesis stage, all of the nucleoli are of approximately the same size. Later, however, there is a marked decrease in the size of all except one, which does not appreciably change. Similar phenomenon has been observed by REEVES (1930) in alfalfa. The behavior of chromatin and nucleoli in this stage or in the prophase, as described above, indicates the existence of a genetic relationship between these structures as suggested by many authors.

*Homoeotypic nuclear division.*—Two homoeotypic spindles are formed, and the chromosomes arrange themselves on the spindle (Pl. XXII, fig. 9 and 10), and 20 univalent ones pass to the poles in the usual way. After the chromosomes reach the poles (Pl. XXII, fig. 11) they again assume a resting condition. At this time out of the cytoplasm four other spindles arise, making six in the cell, and connect the nucleus to each other. A tetrad with a tetrahedral arrangement of the microspores is formed (Pl. XXII, fig. 12). The original walls of the pollen mother cells disintegrate last (Pl. XXII, fig. 13). The microspores in development contain numerous extranuclear nucleoli and continue to increase in size until they are more than twice their original diameter (Pl. XXII, fig. 14). Division of the

nucleus of the pollen grain occurs before the pollen is shed (Pl. XXII, fig. 14). The generative nucleus then becomes surrounded by a lens-shaped region of cytoplasm and takes a position on one side of the pollen grain. The size of the matured pollen grains of the different varieties is given in Table 3.

TABLE 3. The size of the pollen grains of the *Glycine* species.  
Observed during a period from July 25th to August 4th, 1931.

Species	Name of varieties	Size of one pollen grain in $\mu$		
		Average of 100 grains	Largest grain	Smallest grain
<i>Glycine hispida</i> MAX.	Huang-pao-chu	24.36 $\times$ 22.3	34.8 $\times$ 30.8	20.6 $\times$ 20.6
	No. 982	24.07 $\times$ 23.99	25.8 $\times$ 25.8	20.6 $\times$ 19.35
	Chu-liang-tou	29.96 $\times$ 29.67	34.8 $\times$ 34.58	25.8 $\times$ 24.5
<i>Glycine gracilis</i> SK.	The large line	32.25 $\times$ 31.09	33.6 $\times$ 33.6	29.7 $\times$ 29.7
	The common line	29.78 $\times$ 28.90	33.6 $\times$ 31.0	25.8 $\times$ 24.5
	The small line	30.52 $\times$ 29.62	32.3 $\times$ 31.0	28.4 $\times$ 28.4
	No. 505	29.22 $\times$ 27.86	36.5 $\times$ 31.0	20.6 $\times$ 20.6
	No. 504	22.31 $\times$ 20.90	27.5 $\times$ 23.2	19.35 $\times$ 19.35
	No. 502	29.76 $\times$ 28.71	33.6 $\times$ 32.3	24.5 $\times$ 23.2
	No. 503	28.70 $\times$ 27.48	34.8 $\times$ 31.0	20.19 $\times$ 20.6
<i>Glycine Soja</i> S. et Z.		30.06 $\times$ 28.77	32.3 $\times$ 32.3	20.6 $\times$ 20.6

Plants belonging to the variety which keep blooming for a long time tend to produce many large pollen grains, while those with short blooming season produce smaller ones. None of the soy beans, however, shows any marked difference in the size of pollen grains.

## V. Weight of seeds of the *Glycine* species

Table 1 shows the distribution of the weights of seeds belonging to the varieties used in this study. The frequency distribution of the weight of the seeds in respect of the species under examination is given in Table 4, and illustrated in Figure 6. Table 5 shows the



TABLE 4. Frequency distribution of the weight of the seeds.

Weight of a seed in mg.	<i>G. Soja</i> S. et Z.		<i>G. gracilis</i> SKVORTZOW.				
	Samples from the River Sungari	Cultivated for cattle food	Original samples from SKVORTZOW				
	f	f	f	Weight of a seed in mg.	f	Weight of a seed in mg.	f
1-2	1	—	—	30-31	2	59-60	7
2-3	3	—	—	31-32	2	60-61	7
3-4	14	—	—	32-33	3	61-62	8
4-5	28	—	—	33-34	3	62-63	7
5-6	94	5	—	34-35	3	63-64	6
6-7	109	32	—	35-36	3	64-65	6
7-8	106	25	—	36-37	3	65-66	6
8-9	67	56	—	37-38	5	66-67	6
9-10	40	57	—	38-39	5	67-68	5
10-11	35	52	1	39-40	6	68-69	4
11-12	26	55	0	40-41	7	69-70	4
12-13	7	38	1	41-42	7	70-71	4
13-14	3	29	0	42-43	8	71-72	4
14-15	2	29	0	43-44	8	72-73	4
15-16	1	41	1	44-45	8	73-74	4
16-17	—	35	1	45-46	9	74-75	2
17-18	—	28	0	46-47	9	75-76	3
18-19	—	18	0	47-48	10	76-77	2
19-20	—	15	1	48-49	10	77-78	1
20-21	—	3	1	49-50	15	78-79	1
21-22	—	3	1	50-51	12	79-80	2
22-23	—	2	1	51-52	11	80-81	1
23-24	—	1	1	52-53	10	81-82	0
24-25	—	1	0	53-54	9	82-83	1
25-26	—	2	1	54-55	8	—	—
26-27	—	4	1	55-56	8	95-96	1
27-28	—	—	2	56-57	7	—	—
28-29	—	—	2	57-58	7	—	—
29-30	—	—	2	58-59	7	99-100	1
Total	536	351	321				

biometrical value of the weights of the seeds which are calculated from data given in Table 4.

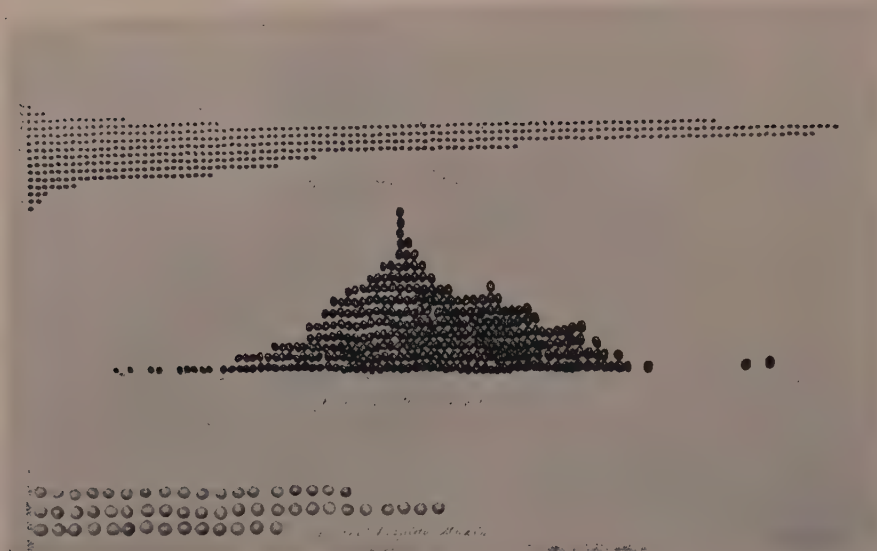


Fig. 6. Seeds of soy beans illustrating frequency distribution of the weight. Upper,—*Glycine Soja* S. et Z. on the bank of the River Sungari. Center,—*Glycine gracilis* SKVORTZOW. Lower,—*Glycine hispida* MAX. (The line improved at the Experimental Station at Kung-chu-ling from the variety Huang-pao-chu).

TABLE 5. Weight of seeds of *Glycine* species.

	Arithmetical mean M	Standard deviation $\sigma$	Coefficient of variation V
<i>Glycine Soja</i> S. et Z. from the River Sungari	$7.45 \pm 0.063$	$2.15 \pm 0.044$	28.72%
Do. cultivated for cattle food	$12.48 \pm 0.122$	$4.16 \pm 0.862$	32.88%
<i>Glycine gracilis</i>	$52.07 \pm 0.510$	$13.60 \pm 0.361$	26.12%

The seeds of *Glycine Soja* S. et Z. grown in bush form, as is often observed on the bank of the River Sungari, are very small, while those gathered from a plant grown alone are relatively heavy,

as in the case of specimens gathered from woods (Table 1). Those taken from plants grown for cattle food are heavier and have wider deviation (Table 5). Compared with *Glycine Soja* S. et Z., *Glycine gracilis* has an even narrower deviation, so that the latter is a good species.

## VI. Genetical difference among the *Glycine* species

When the varieties are arranged in the order of the weight of the seeds belonging to them, it is seen that *Glycine Soja* S. et Z. is on the lightest and *Glycine hispida* MAX. on the heaviest, while *Glycine gracilis* about medium weight. Crossing experiments show that blending inheritance is taking place. The weight of the seeds is an inherited blending characteristics. Many other morphological characteristics are also inherited in the same way. This may also be explained by the fact that they are also the quantative characters produced by multiple factors. Therefore these characters are of Mendelian nature, which are produced by multiple factors.

Though *Glycine gracilis* is a good species, the author has succeeded in producing two races from it, one having larger seeds than the common one, and the other smaller ones. In outer appearances there are resemblances between the race with larger seeds and *Glycine hispida*, and between that with smaller seeds and *Glycine Soja*. The question whether there is any correlation among these Mendelian characters can not be discussed here. But the author has succeeded in picking up a few individuals of the appearance of *Glycine Soja* S. et Z. with relatively large seeds which are almost as large as these of the common race (*Soja* type of *Glycine gracilis*) and those of the appearance of *Glycine hispida* MAX. with relatively small seeds which are also almost as large as those of the common race (*Hispida* type of *Glycine gracilis*) (Fig. 7). Among cultivated varieties the Chuliang-tou may be supposed to be *Hispida* type of *G. gracilis*. The author has in the course of the present investigation frequently observed *Soja* individuals which sometimes take erect form.

Therefore it may tentatively be concluded that the different characteristics of the various varieties of soy beans are caused by the difference in the combination of Mendelian factors of multiple nature.



Fig. 7. *Glycine gracilis* SKVORTZOW. Left—*Hispida* type.  
Right—*Soja* type.



## VII. Origin of soy beans

SKVORTZOW and the author have so far found no erect form of soy bean grown in a wild state in Manchuria. One of the varieties which was mentioned as wild by KAWAKAMI (1930) is also included by him in the group of horticultural races. The wild *Glycine hispida* MAX. found by YABE (1903) at Ying-kou may probably be a plant belonging to *G. gracilis*.

The author has found no cytological differences among *Glycine* species. For instance there is remarkable similarity of morphology and number of chromosomes and the size of reproductive cells. The process of pollen production is regular, and no sterile or partial sterile varieties exist among all the varieties of soy beans. It has already been concluded that the different varieties are caused by the difference in the combination of genes of Mendelian characters. Therefore if *Glycine gracilis* is placed between *G. Soja* S. et Z. and *G. hispida* MAX., there should be many intermediate varieties among these three species. There may be distinct evolution from *G. Soja* S. et Z. up to *G. hispida* MAX. *Glycine hispida* MAX. is clearly a domesticated form of *Glycine Soja* S. et Z., and *G. gracilis* is a semi-cultivated form of *G. hispida* MAX. and *Glycine Soja* S. et Z. is the only existing original wild plant of *G. gracilis* and of *G. hispida* MAX.

The genus *Glycine* is large, containing more than two hundred varieties. It may be natural to use these varieties as a unit of classification, for there are no significant gaps in the evolution connecting *G. Soja* S. et Z. and *G. hispida* MAX. But no intermediate varieties between *G. hispida* MAX. and *Glycine Soja* S. et Z. exist outside Manchuria. Therefore it is correct to discriminate *Glycine Soja* S. et Z. from *Glycine hispida* MAX. as separate species, and it may be convenient to group the intermediate varieties between the above two species in one species as has been done by SKVORTZOW who designated them as *Glycine gracilis*.

In regard to the indigenous home of soy beans Manchuria is generally held to be the original center of their distribution, as mentioned by MAKINO and NEMOTO (1931). But the author has unfortunately never come across any definite literature on the origin of soy beans, and therefore, from the stand point of VAVILOV's Gencentren theory, confirms that Manchuria is the original center of the evolution of soy beans, for the following reasons:

1. The intermediate species, *Glycine gracilis*, is distributed widely not only in Harbin but in other parts of Manchuria, while it is not easy to find them outside Manchuria.

2. More than two hundred varieties of soy bean have been found in Manchuria. Moreover many inferior varieties of soy beans are under cultivation in many districts of Manchuria, for instance at Chu-liang-tou (Table 1).

3. Many characteristics of these inferior species are caused by multiple dominant genes, so that when crossing has taken place the *Hispida* characteristics can not easily be segregated even by back crossing. Therefore the characteristics of these inferior races are of a primitive nature, and special variations of character are found only in plants grown in Manchuria.

### VIII. Summary

1. The processes of the development of the pollen grains of any species of *Glycine* genus are regular and are similar to those described by different authors in respect to other species of Leguminosae.

2. The number of chromosomes of *Glycine hispida* MAX., *Glycine gracilis* and *Glycine Soja* S. et Z. is equally 20 in haploid and 40 in diploid.

3. The morphology and number of chromosomes and the size of the reproductive cell are similar in various species of *Glycine*.

4. Evolution connects distinctively *Glycine Soja* S. et Z. and *Glycine hispida* MAX. with *Glycine gracilis* SKVORTZOW taking about a middle position. The order of arrangement in this evolution is almost the same as the order of the weight of the seeds of plants belonging to each variety.

5. Different varieties are caused by the difference in the combination of genes of Mendelian characters.

6. Although there exist many intermediate varieties, it is convenient to classify various varieties of soy beans into the following three groups: *Glycine hispida* MAX. including various varieties of cultivated soy beans, *Glycine Soja* S. et Z. including those of original wild soy beans, and *Glycine gracilis* SKVORTZOW including those of intermediate semicultivated soy beans.

7. *Glycine Soja* S. et Z. is the only existing wild plant of *Glycine gracilis* SKVORTZOW and of *Glycine hispida* MAX.

8. Manchuria should be considered as the indigenous home of soy beans from the stand point of VAVILOV's Gencentren theory.

MANCHURIA MEDICAL COLLEGE,  
JAPANESE CONCESSION,  
MUKDEN.

### IX. Literature cited

1. ENGLER, A. und PRANTL, K. (1894) Die natürlichen Pflanzenfamilien. Teil III, Abt. 3, p. 360. Leipzig.
2. INOUE, C. (1929) On the connection between the nucleolus and the spireme in pollen mother cells. Proc. Crop Sci. Soc. Japan. No. 4, p. 78. Tokyo.
3. ——— (1929) Studies on the development of chromosomes in *Linum*. Proc. Crop Sci. Soc. Japan. No. 3, p. 39–56. Tokyo.
4. ——— (1929) Studies on the development of chromosomes in *Hordeum*. Proc. Crop Sci. Soc. Japan. No. 5, p. 29–39. Tokyo.
5. ——— (1932) Meiotic mitosis in *Hordeum sativum*. Proc. Crop Sci. Soc. Japan. Vol. 4, No. 4, p. 304–314. Tokyo.
6. KAWAKAMI, J. (1930) Chromosome numbers in Leguminosae. Bot. Mag. Tokyo. Vol. 44, No. 522, p. 319.
7. MAKINO, T. and NEMOTO, K. (1931) Flora of Japan. 2nd. Ed. p. 571–572. Tokyo.
8. REEVES, R. G. (1930) Nuclear and cytoplasmic division in the microsporangogenesis of alfalfa. Amer. Journ. Bot. 17, No. 1, p. 29–40.
9. SAKAMURA, T. (1914) Ueber die Kernteilung von *Vicia cracca* L. Trans. Sapporo Nat. Hist. Soc. Vol. 5, pt. 4, p. 111–124.
10. ——— (1914) Studien über Kernteilung bei *Vicia cracca* L. Bot. Mag. Tokyo, Vol. 28, p. 131–141.
11. SKVORTZOW, B. V. (1927) The soy bean—wild and cultivated in Eastern Asia. Proc. Manchuria Research Society, Natural History Sect. Series A. Facs 22. Harbin.
12. TERAOKA, H. and NAKATOMI, S. (1929) On the inheritance of chlorophyll colorations of cotyledons and seed-coats in the soy bean. Japan. Journ. Gen. Vol. 4, No. 2, p. 64–80.
13. VAVILOV, N. I. (1928) Geographische Genzentren unserer Kulturpflanzen. Zeitschr. indukt. Abst. u. Vererbungsl. Suppl. Bd. 1.
14. WEINSTEIN, A. I. (1926) Cytological studies on *Phaseolus vulgaris*. Amer. Journ. Bot. 13, p. 248–263.
15. YABE, K. (1903) An enumeration of plants hitherto known from South Manchuria. Pub. S.M.R. Co. Manchuria.

## X. Explanation of plates XXI-XXII

All the figures are photographed to the size of 1000 times.

### PLATE XXI

- Fig. 1. Resting stage of the pollen mother cells (*Glycine hispida* MAX).
- Fig. 2. Early synizesis, showing thready balls (*G. hispida* MAX).
- Fig. 3. Later than synizesis showing thready loops passing out (*G. hispida* MAX).
- Fig. 4. Open spireme (*G. hispida* MAX).
- Fig. 5. Diakinesis showing pairs of chromosomes loosely associated (*G. gracilis* SKVORTZOW).
- Fig. 6. Heterotypic metaphase (*G. gracilis*). The upper cell on the left shows 20 chromosomes in polar view of the heterotypic nuclear plate. The cell on the right shows side view of the same.
- Fig. 7. Do. The cell in the middle shows 20 chromosomes in polar view of the heterotypic nuclear plate.

### PLATE XXII

- Fig. 8. Interkinesis (Chu-liang-tou).
  - Fig. 9. Homoeotypic metaphase (*G. gracilis* SKVORTZOW). Side view of only one spindle of a pair of spindles is shown in each cell.
  - Fig. 10. Anaphase of the homoeotypic division (*G. gracilis* SKVORTZOW).
  - Fig. 11. Telophase of homoeotypic division (*G. gracilis* SKVORTZOW).
  - Fig. 12. Tetrads (*G. gracilis* SKVORTZOW).
  - Fig. 13. Young pollen-grains (*G. gracilis* SKVORTZOW).
  - Fig. 14. Mature pollen-grains (*G. gracilis* SKVORTZOW).
-



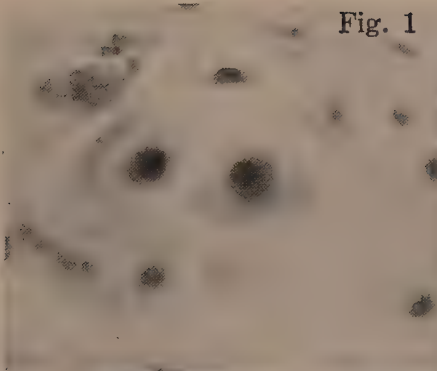


Fig. 1

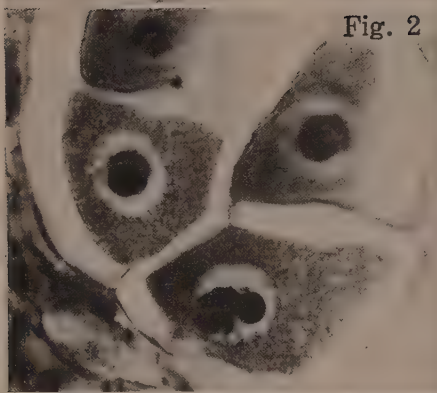


Fig. 2

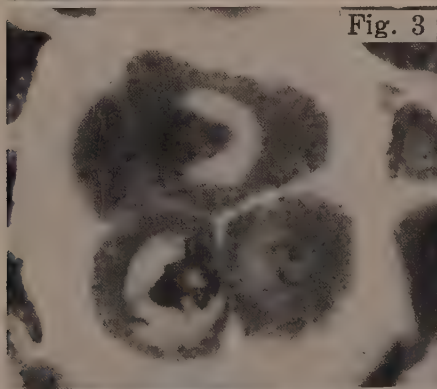


Fig. 3



Fig. 4

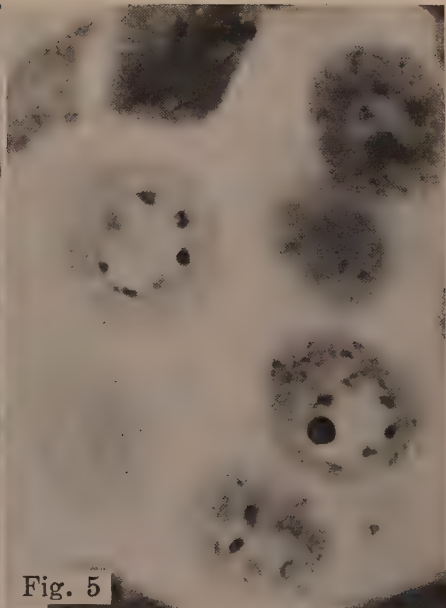


Fig. 5

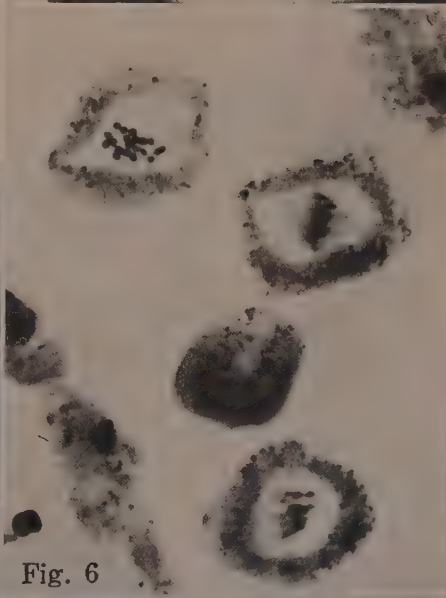


Fig. 6



Fig. 7



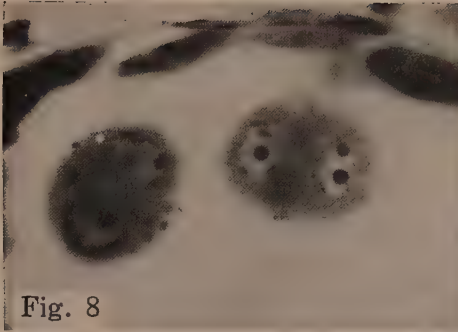


Fig. 8

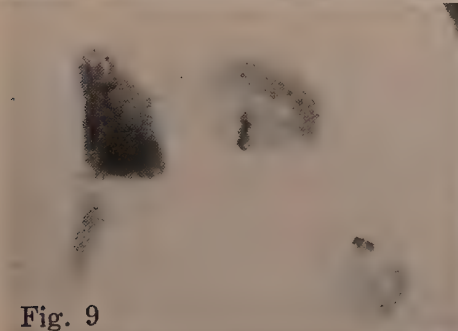


Fig. 9

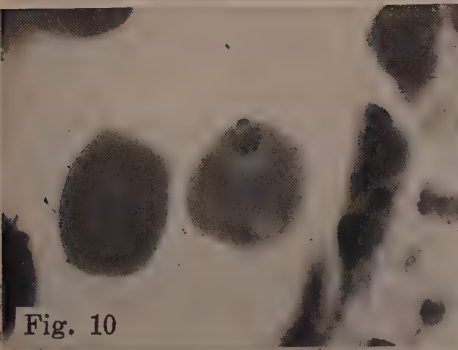


Fig. 10

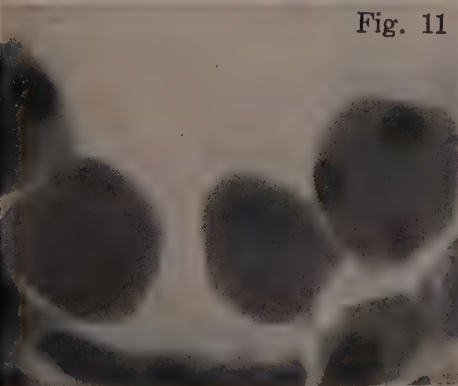


Fig. 11

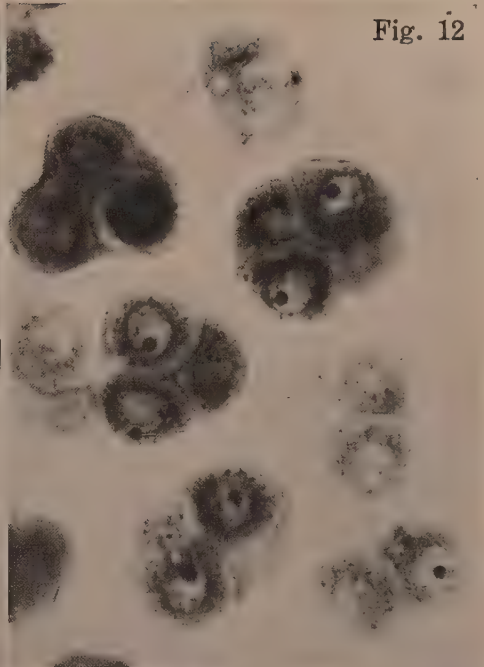


Fig. 12

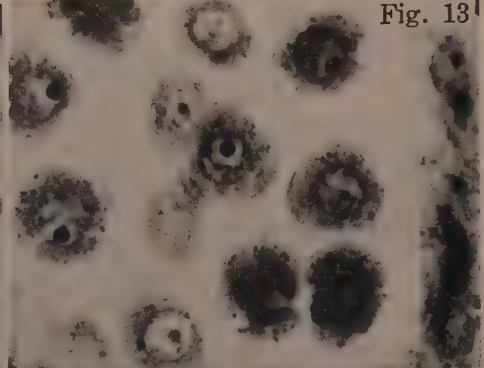


Fig. 13

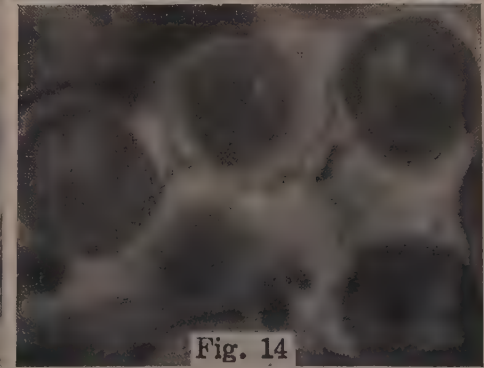


Fig. 14





# On the overwintering of *Peronoplasmodium* *cubensis* (B. et C.) CLINTON

By Makoto HIURA and Shigehiro KAWADA

---

With plate XXIII

---

(Received August 25, 1933)

## Introduction

The downy mildew of cucumber is one of the well-known diseases of agricultural plants. It is commonly found in the cucumber-growing regions of the world, and often causes a serious damage to the grower.

In 1869, BERKELEY (1) of England first described a new fungus parasitic on some cucurbitaceous plant collected by CHARLES WRIGHT in Cuba, and named it *Peronospora cubensis*, B. et C. Nothing was reported of the disease until 1888, when TANAKA (9) of Japan reported that a downy mildew trouble had been found on the cucumber cultivated in the vicinity of Tokyo. Next, in 1889, HALSTED (5) in the United States of America reported the occurrence of a serious *Peronospora* trouble on green house cucumbers in New Jersey. In the same year, FARLOW (3) informed that the cucumber downy mildews in Japan and America are one and the same, being identical with *Peronospora cubensis*, B. et C. His identification was based on the examination of HALSTED's specimens and also of the specimens collected by N. TANAKA at Minowa, Tokyo, which had been sent by him to K. MIYABE, then a student in the Harvard University, Cambridge, Mass., together with his beautiful sketch of some conidia and of those germinating by zoospores. FARLOW also stated in the same note that K. MIYABE had recently examined the BERKELEY and CURTIS type specimen of *Peronospora cubensis*, B. et C. at Kew, London and found the Japanese fungus on cucumber to be identical with it.

Thereafter, numerous papers concerning the occurrence of the disease, effect of spraying, and the taxonomy of the causal fungus

have been published. It is however evident from the literature of the disease that the life-cycle, especially hibernation of the causal fungus has long been a puzzling problem of interest for mycologists as well as for plant pathologists. The present investigation deals mainly with such an unsolved phase of the life-history of *Peronosplasmopara cubensis* (B. et C.) CLINTON.

### Earlier works on the hibernation of the fungus

The fungi belonging to the family Peronosporaceae are generally known to produce large, thick-walled resting spores or oospores. Since the fungus under consideration belongs to the same family, most of the previous workers expected the existence of the oospore, and tried to prove it. It has however been reported by all the investigators of this fungus, except by TANAKA (10) and ROSTOWZEW (8) that no oospores were found.

In 1890, TANAKA (10) stated to have succeeded to find only three oospores of the fungus, and believed that the fungus overwinters by means of oospores.

In 1903, ROSTOWZEW (8) claimed to have found half-matured oospores of the fungus in affected leaves of cucumber, and also stated that the oospores apparently complete their full development in the decaying leaves in the ground. His inoculation experiment with soil obtained from the infected region showed that the cucumber on the bed inoculated with the infected soil began to indicate yellowish spots on the leaves lying near the ground at the end of May, while the plants growing in the soil not inoculated remained healthy. From these studies, he was convinced that the fungus winters over by means of the oospores in the soil.

In 1905, CLINTON (2) published the results of his extensive studies on the downy mildew of cucumbers and melons. In spite of all his efforts to search out the oospores of the fungus, no evidence was obtained that suggested the fungus developing such a stage, and he pointed out that there is need of more evidence of the nature and identity of ROSTOWZEW's immature oospores before they can be accepted or rejected as being connected with the mildew, since other fungi often develop quite early in the dead spots of the leaves killed by the mildew. CLINTON suggested two possible ways of the hibernation of the fungus as follows:

(1) The fungus in some places is carried over winter by cucumbers, etc., raised in green houses and later in hot-beds, finally spreading to outdoor plants in the summer.

(2) The fungus may overwinter in the south on hosts that grow outdoors all the year round, and would advance northward with the season, and its appearance would be greatly influenced by the character of the weather each year.

Since CLINTON's investigations were published, the hibernation question of the fungus has been lost in mystery. Some doubted the presence of the oospore, while others believed the overwintering of the fungus by the oospores without having reliable evidence. In this connection the following references from Japan will be of special interest.

In 1919, FUKUI (4) reported the results of his field studies on the control of the cucumber downy mildew. His intention was to find out a simple way to prevent the disease without using bordeaux mixture. As he was confident from his field observations that the disease comes primarily from the infected soil, he put straw mulch around the base of the cucumber plants in the infected soil in order to avoid spattering of soil particles on the lower leaves lying near the ground. This brought forth a result that the disease was greatly reduced, while the control plants which were grown without straw mulch became seriously infected in the same infested soil. From these observations and experiments he concluded that the fungus hibernates in the soil, although it is unknown in what way the fungus survives over winter in the soil.

In 1927, KUROSAWA (7) of Formosa reported that the fungus can overwinter on cucumber plants under Formosan conditions.

In 1929, HIURA (6) reported that the fungus generally hibernates in the soil, as his careful field observations extending over several years verified that the sign of the disease first appears on the lowermost leaf of cucumber plants without exception.

It is thus seen that while CLINTON's suggestions concerning the overwintering of the fungus may be quite possible in certain localities, evidences favoring the hibernation of the fungus in the soil have also been accumulating, and special interest attaches at present to proving how the fungus survives over winter in the soil.

### The presence of the oospore

Preliminary experiments have shown that the conidia of *Peronoplasmopara cubensis* are viable over a month in the laboratory conditions during June in our district. It seems not improbable that the conidia will live much longer if they are kept under more favorable conditions. Our experiments concerning the viability of the conidia have however failed to show any evidence of the conidia being able to hibernate in the soil. Attention has naturally been directed to seek for the oospores of the fungus in the affected leaves.

In the summer of 1927, the senior author collected some leaves of cucumber attacked severely by the downy mildew in Sapporo, Hokkaido. Affected portions were cut out, and placed upon the 2% agar-agar slant in large test tubes plugged with cotton. Bringing these back to Gifu, he examined the tissues of the lesions under a microscope about in the middle of September, and found several oospores in one of these cut-lesions. Of course, he suspected them to be the oospores of the causal fungus, but was not confident of it, since such oospores were not found in the other lesions, so far as his examinations were made at that time. Since then, his attention has been paid every season to discover the oospores of the fungus, but without success.

In the beginning of this year, he collected many affected leaves of cucumber downy mildew from the green house in the Experimental Farm of our College. They were put in a few large Petri-dishes, and left on the table in the laboratory. Later in April, the junior author examined one of these affected leaves under a microscope by dissecting a lesion with needles. Many oospores happened to be found. Being encouraged with this, we continued to examine the remaining specimens one by one. It was finally found that oospores were present in several of these leaves. The leaves containing oospores were however very small in number. It became also aware of a fact that the leaves in which oospores were present were chiefly small upper ones of plants affected severely.

In order to demonstrate the connection of the oospores with the mycelia in the leaves, cut-lesions were immersed in the 20% KOH solution for 24 hours or more, and then dissected gently by means of needles. In this way, the connection between the oospores and the characteristic mycelia of the fungus was easily proved as clearly shown in the plate.



In June and July, we were again engaged in looking out for the oospores from the affected leaves of cucumber growing in fields. Ten to twenty of severely affected leaves were collected from several cucumber fields, and three or four lesions of each leaf were examined under a microscope. In most of the affected leaves collected from a field at Hosobata near Gifu were found abundant oospores, while in the leaves brought from the pathological garden of our college only a small number of oospores were found and in those from other fields near our college no oospores were searched out. Through these examinations the following salient points have been cleared up:

(1) the amount of the oospores varies greatly not only in the affected leaves obtained from different fields, but also in the different lesions even in one and the same leaf.

(2) the oospores are in general present more abundantly in the upper leaves than in the lower of the cucumber.

(3) late in June onward, oospores are found even in young lesions which are still not much discolored, and mature oospores are commonly found in the lesion of the affected leaves which are vigorous in appearance, attaching to the plant.

(4) the oospore is so far not found in the tissues of apparently healthy parts of the affected leaf around the lesions.

(5) these oospores are formed on the characteristic hyphae of the fungus in question.

The oogonia are found to be obovoid to ellipsoidal, or irregularly pyriform in shape,  $28-56 \times 24-44 \mu$  in size, and the antheridia are clavate to globose, and  $14-22 \times 10-16 \mu$  in size. The oospores are spherical, rarely obovoid to ellipsoidal, and  $22-42 \mu$  in diameter; the oospore-wall is smooth, hyaline to slightly yellowish, and  $1.5-3.5 \mu$  in thickness.

TANAKA (10) gave no description of the oospores he found, and it is impossible to determine whether he found true oospores of *Peronoplasmodium cubensis* or not. ROSTOWZEW (8) gave the description as well as the figures of the oospores found by him. The comparison of his description and figures with ours evidently shows that the oospores found by ROSTOWZEW are entirely different from those discovered by us in that the former are undulate-warty in shape. At present we are unable to accept ROSTOWZEW's oospores being connected with the fungus of the cucumber downy mildew. At any rate, the results of the present investigation show to suggest strongly the possibility of the hibernation of the fungus in the soil, which has

long been supposed by certain investigators. Further studies on the relation of these oospores to the primary infection of the cucumber downy mildew are now in progress.

In conclusion, the authors wish to express here their heartiest thanks to Emeritus Prof. Dr. K. MIYABE of the Hokkaido Imperial University, Sapporo, for valuable suggestions in revising the manuscript.

DIVISION OF PLANT PATHOLOGY,  
IMPERIAL COLLEGE OF AGRICULTURE,  
GIFU, JAPAN.

---

### Literature cited

1. BERKELEY, M. J. On a collection of fungi from Cuba. Part II. No. 646. *Peronospora cubensis*, B. et C. Journ. Linn. Soc., Botany, **10**: 363, 1869.
2. CLINTON, G. P. Downy mildew or blight of muskmelons and cucumbers. Conn. Agr. Exp. Sta. Ann. Rept., 1904: 329-362, 1905.
3. FARLOW, W. G. Notes on fungi I. Bot. Gaz. **14**: 189-190, 1889.
4. FUKUI, T. A control-method of the cucumber downy mildew (in Japanese). Byochu-Gai Zasshi **6**: 937-940, 1919.
5. HALSTED, B. D. Some notes upon economic Peronosporae for 1889 in New Jersey. Journ. Myc., **5**: 201-203, 1889.
6. HIURA, M. Studies on some downy mildews of agricultural plants. II. Relation of meteorological conditions to the downy mildew of cucumber (in Japanese). Kagami Kenkyû Hôkoku, No. **6**, 1929.
7. KUROSAWA, H. On the characters of the cucumber downy mildew fungus (in Japanese). Trans. Nat. Hist. Soc. Formosa, **17**, No. 88, 1927.
8. ROSTOWZEW, S. J. Beiträge zur Kenntnis der Peronosporen. Flora, **92**: 405-430, 1903.
9. TANAKA, N. A fungus parasitic on cucumber (in Japanese). Bot. Mag. Tokyo, **2**: 143, 1888.
10. ———, On the specific name of the cucumber downy mildew fungus prevalent in the vicinity of Tokyo in the summer of the year before last (in Japanese). Bot. Mag. Tokyo, **4**: 38-40, 1890.

---

### Explanation of plate XXIII

Figs. 1-4: Oogonia.

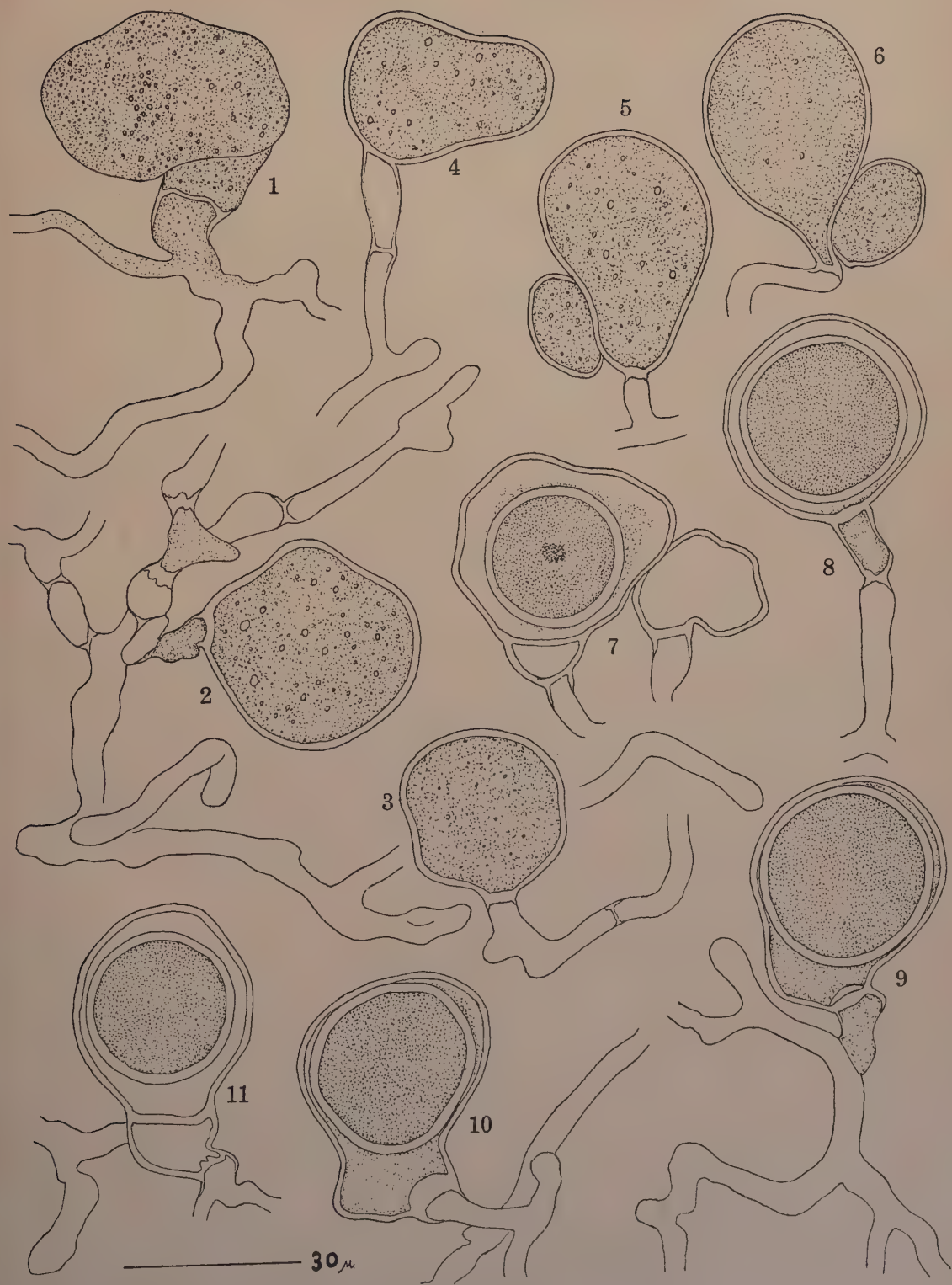
Figs. 5-6: Oogonia and antheridia.

Figs. 7-11: Oospores.

---









## Abstracts Nos. 1—76

(Referring to the principal papers on Botany and allied subjects which have appeared in Japan chiefly during July - December 1931)

**1. Diagnosis specierum novarum caricum.** (With Japanese résumé). Shigeo AKIYAMA. (Bot. Mag. Tôkyô **45**, 1931, 472-474, 494-495).

The following new species of *Carex* are described: *C. kiyozumiensis*, *C. nikomontanus*, *C. shakushizawaensis*, and *C. Honda*.

**2. Über einige Myxomyceten.** (Deutsch und japanisch). Yoshikadzu EMOTO. (Bot. Mag. Tôkyô **45**, 1931, 551-554, 1 Taf.).

Eine neue Art, *Physarum nasuense* wird beschrieben. Die Beschreibung bezieht sich auf das Sporangium und Sporen. Kein Plasmodium wurde beobachtet.

**3. Genetico-physiological studies in the seed-colour of Japanese morning glory.** (Japanese with English résumé). Tokio HAGIWARA. (Japan. Jour. Gen. **7**, 1931, 1-16, with 2 text-figs.).

Seeds of *Pharbitis Nil* (Japanese morning glory) are black, brown or white. Black is dominant to brown and white, while brown in its turn is dominant to white. In  $F_2$  the monohybrid segregation takes place, as previously noticed. In  $F_2$  of the hybrid white  $\times$  brown we have either brown: white = 3:1 or black: brown: white = 9:3:4. The above fact is easily comprehensible, if we assume the two genes  $C^a$  (for chromogen) and  $O$  (for oxydizing enzyme) which are concerned in the production of seed colours, thus we have black =  $C^aO$ , white =  $caO$  or  $cao$ , brown =  $C^ao$ .

In black seeds blackish brown pigments are present in the epidermal cells of seed-coat, and thinly brown ones in its subepidermal cells, while in brown seeds both epidermal and subepidermal layers contain thinly brown pigments only. In white seeds no pigments at all are present. The pigments above stated are considered to be phlobaphenes, which are produced by the action of the oxidase or peroxidase upon chromogen consisting of a pseudobase of unknown chemical constitution.

**4. The genetics of flower colours in *Pharbitis Nil*.** Tokio HAGIWARA. (Jour. Coll. Agric. Imp. Univ. Tokyo **11**, 1931, 241-262, 1 col. pl.).

The flower colour of *Pharbitis Nil* may be first of all classified into three groups, viz. pure, broken and white. The pure colour which is bright in its hue contains blue, purple, magenta and red. The broken colour which is dull in its hue, includes two classes, each containing four dull hues corresponding to four normal pure colours. Broken colour I class (dusky) contains slate, plum, terra-cotta I and II, while broken colour II class contains gray, drab, vinaceous I and II.

All the colours above indicated are due to anthocyanin pigments, while white group is destitute of them. By means of a great number of crossing experiments the

author has ascertained the genes concerned in the production of all flower colours above mentioned, and the genotype formulae for all of them are indicated.

**5. Über die Beeinflussung des Wachstums des Mesokotyls und der Koleoptile von *Avena*-Keimlingen durch das Licht.** Hideo HAMADA. (Mem. Coll. Sc., Kyoto Imp. Univ., Ser. B 6, 1931, 161-238, 36 Textabb.).

Es ist unmöglich, hier alle einzelnen Tatsache hervorzuheben, welche in dieser inhaltsreichen Abhandlung über die Haferkeimlingen enthalten sind, nur die hauptsächlichsten Punkte davon werden im folgenden kurz referiert werden.

Im Dunkel nimmt das Wachstum von Mesokotyl, Koleoptile und Primärblatt einen S-förmigen Verlauf. Insbesondere hat der Verf. die Hemmung dieses Wachstums durch den Lichtreiz verschiedener MK studiert. Dadurch bekommt man eine V-förmige Endlängenkurve, welche als Hemmungskurve bezeichnet wird. So z.B. durch Behandlung durch das 15 MK Licht während je 3, 6, 12, 24 oder 48 Stunden erfährt das Mesokotyl die stärkste Hemmung seines Wachstums im Alter von 48 Stunden nach dem Aussaat, während die Koleoptile nicht so deutlich beeinflusst wird. Durch die Behandlung durch 510 MK Licht wird der tiefste Punkt der Hemmungskurve im 51-stündigen Alter erreicht, sowohl beim Mesokotyl als beim Gesamtspross d.h. Mesokotyl+Koleoptile). Weiter durch die halbstündige Beleuchtung mit 1260 MK kommt für das Mesokotyl die grösste Hemmung z.B. im Alter von 36, 51 und 120 Stunden nach dem Aussaat, und für die Koleoptile 1,5-2 Tage danach. Bei 5-30 Minuten lange Belichtung mit 1260 MK befindet sich das Tal der V-förmigen Kurve im 51- oder 54-stündigen Alter und mit zunehmender Lichtmenge wird die Kurve asymmetrischer. Durch die 2-tägige Belichtung im Anfangsstadium mit 1260 MK wird das Wachstum des Mesokotyls so gehemmt, dass die Keimlingen fast mesokotylfrei sind, während durch die 3-tägige oder längere Belichtung man die kürzeste Koleoptile bekommt.

Für alle andere Angabe sei auf das Original verwiesen. (Vgl. auch Japan. Jour. Bot. 5, (2), Nr. 8).

**6. A new *Caulopteris* from the Wu-hu-tsui coal-field of South Manchuria, *Caulopteris manchuriensis* sp. nov.** Nobuhiro HATAE. (Japan. Jour. Geol. and Geogr. 9, 1931, 9-11, 1 text-fig.).

*Caulopteris manchuriensis* sp. nov. is described. It closely resembles *C. grandis* ZEIL. and also reminds of *C. perfecta* and *C. endorrhiza* GRAND'EURY.

**7. Heredity of intersexuality in hemp.** (Japanese with English résumé). Kenji HIRATA. (Japan. Jour. Gen. 7, 1931, 103-105).

The female intersexes of *Cannabis sativa* were self-pollinated during several generations, and it was found, that 1. no male progeny appeared, 2. the frequency of the production of female intersexes increased gradually generation after generation with the consequent decrease of that of pure females, which finally were not produced at all. The percentage of seed germination generation after generation was observed. The general conclusion attained by the author was that the intersexuality of hemp is due to the genotypic cause, and not to the environment.



**8. On the occurrence of female intersexual plants in *Spinacia* and *Melandrium*.** (Japanese with English résumé). Kenji HIRATA and Kengo YAMAMOTO. (Japan. Jour. Gen. **7**, 1931, 106-107).

Seeds got by self-pollination of intersexual plants of *Spinacia oleracea* and *Melandrium rubrum* give rise to females and intersexes, but not to males, wherefrom the authors conclude that the original intersexual plant is the genotypical female.

**9. Nuntia ad floram japonicae XII-XIV.** (With Japanese résumé). Masaji HONDA. (Bot. Mag. Tôkyô **45**, 1931, 297-300, 314-317, 421-423, 454-455, 469-471, 493-494).

The following new species are described among others: *Draba Oiana*, *Trisetum kitadakense*, *Scutellaria Suzukiana*, *Eriocaulon Sekimotoi*, *Spiraea prunifolia*, *Boehmeria pseudo-Sieboldiana*, *Lecanorchis nigricans*. Besides a number of new varieties and forms are enumerated.

**10. Studies on the Hepaticae of Japan. V.** Yoshio HORIKAWA. (Jour. Sc. Hiroshima Univ., Ser. B, Div. 2, **1**, 1931, 58-76, 3 pls. and 10 text-figs.).

The following new species are described with illustrations: *Fimbriaria liukiunensis*, *Alicularia connata*, *Plagiochila minor*, *P. ishizuchiensis*, *P. pulcherrima*, *Zoopsis liukiunensis*, *Colura Inuii*, *Physocolea oshimensis*, *P. spinosa*, *P. nipponica*, *Leptocolea longilobula*. Besides some species, incl. new combinations of the author, are enumerated.

**11. On the Clavariaceae of Japan III. The species of *Clavaria* found in Hokkaido and Southern Saghalien.** (With Japanese résumé). S. IMAI. (Trans. Sapporo Nat. Hist. Soc. **12**, 1931, 9-12).

27 species of *Clavaria* are enumerated. The artificial key for their determination is given. For each species the synonyms, habitat, Japanese names, and some remarks are appended.

**12. Über die Dorsiventralität der unifazialen Blätter von *Iris japonica* THUNB., und ihre Beeinflussbarkeit durch die Schwerkraft.** Shun-ichiro IMAMURA. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B, **6**, 1931, 271-331, 2 Taf. u. 17 Textabb.).

Bei *Iris japonica* stehen die dorsiventralen Blätter, im Gegensatz zu den meisten *Iris*-arten, zur Lotrichtung geneigt. Die Dorsiventralität äussert sich hauptsächlich darin, dass 1. die Stomata auf die Unterseite beschränkt sind und 2. die Oberseite ein palisadenartiges und die Unterseite ein schwammparenchymatisches Gewebe aufweist. Dass diese Dorsiventralität durch die Schwerkraft induziert wird, konnte der Verf. auf Grund zahlreicher Versuche beweisen. So z.B. durch Umkehrung der Pflanze konnte er das Palisadengewebe an der entgegengesetzten Seite des wachsenden Blattes hervorrufen, und durch wiederholte Umkehrungen bekommt man ein sog. Mosaikblatt, welches teilweise die physiologische Oberseite und teilweise die physiologische Unterseite darstellt. Dass solches Phänomen der Wirkung der Schwerkraft und keineswegs derselben des Lichtes zu verdanken ist, ist klar, denn

es kann im völligen Dunkel stattfinden. Dies wurde weiter dadurch bewiesen, dass auf dem Klinostat die Pflanze die mehr oder minder bilateral gebauten, auf den beiden Seiten stomataführenden Blätter ausbilden konnte.

**13. Somatic mitosis in *Hordeum sativum*.** (Japanese and English). Choyo INOUE. (Proc. Crop Sc. Soc. Japan **3**, 1931, 319-335, 1 pl.).

The mitosis in the male archesporium, glume and root-tip of *Hordeum sativum* was studied. In the telophase of a nuclear division, when the preparation for the next division begins, the chromosomes forming an irregular mass by their fusion begin to separate from each other. In such chromosomes the longitudinal vacuole appears so as to split each of them partially into two threads, or they become gradually slender. The chromatin withdraws by and by from the chromosome, till finally in each nucleus two or rarely more spherical large nucleoli are formed, which contain all chromatin derived from the chromosomes. In such nucleus we distinguish besides these nucleoli the fine reticulum. In the prophase of the next division the reticulum gets the chromatin gradually from the nucleoli with which it is connected, and changes into the spirem consisting of double threads and then into 14 chromosomes (diploid!)

**14. Über die Struktur der Chromosomen.** (Japanisch). Tomoyuki ISHII. (Japan. Jour. Gen. **7**, 1931, 128-139, 18 Textabb.).

Gestützt auf die Beobachtungen an *Tradescantia*, *Rhoeo*, *Tinantia* und *Hosta* kam der Verf. mehr oder weniger vermutungsweise zu den folgenden Schlüssen:

Das Chromosom scheint aus vier folgenden Bestandteilen zusammengesetzt zu sein, nämlich Chromosomenwand, Spiralfaden, Chromomeren und Schutzkolloid (oder Grundkolloid). Bei der Metaphase sind die Chromomeren auf dem Spiralfaden unregelmässig verteilt. Die Windungsweise des Spiralfadens (d.h. Richtung, Grösse, Zahl) ist in ein und demselben Teilungsstadium desselben Individuums konstant. In einer und derselben Zelle kann der Spiralfaden entweder links oder rechts winden. Bei eingeschnürten Chromosomen wird der Zusammenhang des Spiralfadens an der Einschnürstelle unterbrochen.

**15. On the Distribution of ferns in the southern part of Japan proper,** (Japanese). Hiroshi Itô. (Bot. Mag. Tôkyô **45**, 1931, 390-404, 4 text-figs.).

The distribution of ferns in the southern part of Japan, incl. Sikoku Island, Kii, Idu and Bôshû Peninsula was undertaken. The general results attained by the author are as follows:

In the four districts above mentioned the coastal flora contains an abundance of Malayan and Southern Chinese elements, while in the alpine region of Sikoku frigid elements are found. There are many species which are common with those of Corea, Shantung and Central China. The districts are rich in endemic plants, whose distribution agrees with that of Phanerogams. Temperature is the chief agent in bringing out this distribution, while neither geological relation nor humidity has practically any effect whatever upon it.

**16. The inheritance of seed-coat colour in the water-melon.** (Japanese with English résumé). Takeshi KANDA. (Japan. Jour. Gen. **7**, 1931. 30-48, 1 pl. and 1 text-fig.).

A great number of varieties of water-melon (*Citrullus vulgaris*) were cultivated, and by means of their crossing the author could ascertain the following facts:

The presence of seven allelomorphic pairs responsible for seed-coat colour was proven, viz.

*B* and *b* yellow and white colour of the whole surface respectively

*ABC* causing dark reddish yellow colour

*ABCT* causing dark reddish yellow colour on the whole surface

*M* determining the localized black spots on the "Samenschwiele"

*H* causing black dots on the whole surface in the presence of *M*

*K* is the extension factor of black dots on the whole surface, making solid black colour.

The genotypic formula of seed-coat colour in various races of water-melon is given on the basis of the above allelomorphic pairs.

**17. An enumeration of the woody plants recorded from Micronesia, Japanese mandate (in 1929 and 1930).** Ryôzô KANEHIRA. (Bot. Mag. Tôkyô **45**, 1931, 271-296, 327-352, 1 map).

An enumeration of 1263 species of woody plants collected by the author in Palau and Ponape (1929) as well as Saipan, Tinian and Yap (1930).

**18. Variation in the number of bivalent chromosomes in the  $F_1$  hybrids between *Triticum durum* and *Aegilops ventricosa*.** (Japanese with English résumé). Y. KATAYAMA. (Bot. Mag. Tôkyô **45**, 1931, 424-445, 1 pl. and 13 text-figs.).

The  $F_1$  hybrids between *Triticum durum* var. *Reichenbachii* and *Aegilops ventricosa* show in the mother-cells, both of pollen and embryo-sac, 28 chromosomes corresponding to the sum of the haploid numbers in the two parents. The chromosomes are mostly univalent, but there are some bivalents. Each of the latter is derived generally from the autosyndesis between A and B genomes of the *Triticum* parent, and rarely from the allosyndesis between the chromosomes of the two parents. Two chromosomes of one bivalent conjugate loosely at one end, though the compact bivalent was rarely observed.

The author has studied statistically the variation of the number of bivalents. First of all it was found that their number in the pollen mother-cells amounts to 0-4 and that in the embryo-sac mother-cells to 0-3, the distribution curve showing its mode always at 0. The variability of this number under various external conditions was studied, and it was found that among others the temperature is chiefly responsible for it. Thus, for instance, the higher the temperature, the fewer the bivalents, and the difference between the means of the numbers of the bivalents at the two extremes (5,5-6,0° and 23,5-24,5°) varies from 0,20-0,43, so that the difference may well be considered to be statistically significant.

**19. Über den Ansatz und die Keimungsfähigkeit der Körner in reziproken intra- und intergenerischen Bestäubungsversuchen im Weizen- *Aegilops*-Kreise und die Sterilität der  $F_1$ -Pflanzen.** (Japanisch). Y. KATAYAMA. (Agric. and Hort. **6**, 1931, 1909-1924).



Eine Anzahl von Art- und Gattungskreuzungen zwischen *Triticum*, *Aegilops* und *Aegilotriticum* wurden ausgeführt und der Unterschied des Ansatzes und der Keimungsfähigkeit der Körner nach den Kreuzungsrichtungen wurde untersucht. So z.B. wurde es bewiesen, dass bei der Kreuzung zwischen *Triticum* und *Aegilops* (bei beiden  $n=14$ ) der Körneransatz besser ist im Falle, wenn *Aegilops* als ♀ diente als im entgegengesetzten Falle, wenn auch die Keimungsfähigkeit sehr niedrig ist. Bei den Kreuzungen zwischen *Triticum* ( $n=7, 14$  und  $21$ ) und *Aegilotriticum* ( $n=28$ ) scheint es, dass je kleiner die Chromosomenzahl ist, desto schwieriger die Kreuzung gelingen wird, so z.B. wenn man *Triticum vulgare* ( $n=21$ ) benutzt, sind beide der Körneransatz sowie die Keimungsfähigkeit gut.

Bei den Gattungskreuzung, *Aegilops* × *Triticum* bekommt man die Samen, wenn auch der Sterilitätsgrad ziemlich hoch ist.

**20. Genomanalyse bei *Triticum* und *Aegilops*. H. KIHARA. III. Zur Entstehungsweise eines neuen konstanten oktoploiden *Aegilotriticum*. H. KIHARA und Y. KATAYAMA. (Cytologia 2, 1931, 234-255, 24 Textabb.).**

Die somatische Chromosomenzahl der fertilen *Aegilotriticum*-Verbindungen von TSCHERMAK ist von BLEIER (1928) als 56 festgestellt worden. Daraus hat BLEIER geschlossen, dass eine Verdoppelung der bei den  $F_1$ -Bastarden erwarteten Zahl (28) stattgefunden hat. Den Verdoppelungsvorgang selbst konnte er aber nicht erfassen, so dass diese Frage offen gelassen blieb. Die Verfasser der vorliegenden Abhandlung haben ein neues oktoploides fertiles *Aegilotriticum* (*T. dicoccoides* × *Ae. ovata*) hergestellt und die I. Reifungsteilung in den PMZ der  $F_1$ -Pflanzen eingehend untersucht. Sie konnten einwandfrei zeigen, dass in diesem Stadium eine Verdoppelung der Genome auf zweifache Weise stattfindet: 1. durch Regression, 2. durch "normale" Entwicklung der Univalenten. Nach den Verf. ist praktisch die erste Möglichkeit ausschliesslich oder fast ausschliesslich in Betracht zu ziehen, weil a) nur in Antheren (bzw. Antherenfächern), die Regression aufweisen, genügend viele taugliche Pollen gebildet werden, um eine normale Dehiscenz zu ermöglichen und b) eine "normale" Entwicklung der Univalenten bei der von den Verf. hergestellten Verbindung zu recht seltenen Fällen gehört.

Die Reifungsteilungen der 56-chromosomigen fertilen  $F_2$ -Pflanze sind ebenfalls näher studiert worden. Chromosomenaberrationen, die BLEIER auf Grund des genetischen Verhaltens annimmt, sind von den Verf. tatsächlich festgestellt worden.

Ausserdem sind auch die Reifungsteilungen bei den heteroploiden sterilen Geschwisterpflanzen des fertilen *Aegilotriticum*- $F_2$  untersucht worden. Ihre Sterilität ist nach den Verf., in Uebereinstimmung mit der von KIHARA im J. 1924 geäusserten Auffassung, auf die Unvollständigkeit der sie kombinierenden Genome (eines oder mehrerer) zurückzuführen. Auch einige andere sterile Verbindungen sind herangezogen worden. Von besonderem Interesse ist die Angabe, dass bei einem dieser Bastarde (*Ae. triuncialis* × *Ae. ovata*), bei dem von den 4 verschiedenen Genomen (2 von *Ae. triuncialis*, 2 von *Ae. ovata*) nicht alle vollständig waren, trotz sehr häufiger Regression keine funktionsfähigen Gonen gebildet wurden; dieser Befund bestätigt in schöner Weise die oben erwähnte Auffassung KIHARA's über eine der wichtigsten Ursachen der Sterilität bei den Weizen- und *Aegilops*-bastarden. F.



**21. Karyomorphologische Untersuchungen an *Rumex acetosa* L. und *Rumex montana* DESF.** H. KIHARA. und Y. YAMAMOTO. (Cytologia 3, 1931, 84-118, mit 71 Textabb.).

Ausser der Bestätigung der früheren Resultate von KIHARA und ONO (1923) betreffs der Geschlechtschromosomen enthält die Arbeit wichtige Beiträge 1. zur karyomorphologischen Differenzierung des Autosomenbestandes und 2. zur Frage der Intersexualität bei *Rumex*.

1. Verf. haben innerhalb der Art *Rumex acetosa* L. in bezug auf den Autosomenbestand 5 verschiedene Karyotypen nachgewiesen:

Karyotyp	I	12i
	II	10i+2v
	III	8i+2J+2v
	IV	8i+2v+2T
	V	6i+2J+2v+2T

(i=Köpfchen-, v=v-förmige, J=ungleichschenklige, T=Trabanten-Chromosomen). Ähnliche Karyotypen sind auch bei *R. montanus* DESF. gefunden worden. Unter den Karyotypen von *R. acetosa* kommt der erste nur in Sendai vor, wo er die vorherrschende Form ist; im Material von anderen Standorten ist er nicht gefunden worden. Verf. sehen ihn als den primären Typ an und führen die Gestaltänderungen der i-Chromosomen auf zwei Möglichkeiten zurück: a. Verschiebung der kinetischen Spalte, b. Translokationen. Bemerkenswert ist, dass die verschiedenen Karyotypen innerhalb einer LINNÉschen Art vorkommen und miteinander gut kreuzbar sein dürften. Für den Karyotyp I und II ist es auch sichergestellt, dass das v-förmige Autosom mit einem der i-Chromosomen zu einem Paare zusammentritt. Nähere Untersuchungen über diese Frage sind im Gange. Sie sollen auch die Entscheidung zwischen den oben erwähnten Annahmen a und b bringen.

2. Verf. haben ein triploides Intersex (mit der Chromosomengarnitur:  $15i+3v+2X+Y_1+Y_2$ , also zum Karyotyp II gehörend) und seine verschiedene Chromosomenzahlen und Geschlechtsverhältnisse zeigende Nachkommenschaft, besonders ein 17-chromosomiges Männchen ( $11i+2v+X+2Y_1+Y_2$ ), eingehend karyomorphologisch (auch äusserlich morphologisch) untersucht. Sie kommen zu dem wichtigen Schluss, dass die Intersexualität bei *R. acetosa* eine parallele Erscheinung zu der bei *Drosophila* vorkommenden.

Es bedarf ausserdem besondere Erwähnung, dass die Fixierungstechnik von den Verf. ausserordentlich sorgfältig an Hand zu diesem Zweck angestellter Versuche ausgearbeitet worden ist. Die Abkühlungsmethode KIHARA's (1927) erwies sich dabei als sehr brauchbar. Die besten Resultate lieferten die Temperaturen zwischen 5 und 12°C; bei ihrem Gebrauch konnten Verf. nicht nur in PMZ, sondern auch in Archespor- und Tapetenzellen Gestalt und Zahl der Chromosomen genau feststellen. L.

**22. Division, growth and differentiation of cells in the root of *Vicia Faba* artificially inhibited from further elongation.** Hitoshi KOJIMA. (Jour. Departm. Agric. Kyushu Imp. Univ. 3, 1931, 121-147, 2 text-figs.).

The growing root of young seedlings of *Vicia Faba* were either imbedded in gypsum or immersed in concentrated cane-sugar solution. The elongation of root is

perfectly or almost perfectly inhibited by this process. The cell-division is equally almost perfectly inhibited by the same process, as clearly seen from the scarcity of mitotic figures. The length of each individual cell in such root is however never less than that of the control root placed under normal condition. The author comes therefore to the conclusion that the inhibition of root elongation is not attributable to the small size of the constituent cells, but to the almost complete cessation of cell-division caused by the pressure, either mechanical or osmotic, which acts probably indirectly.

The differentiation of the root under pressure advances nearer to the apex than in the control, thus, for instance, the tracheal elements appear in the former at an average distance of 5.0–1.4 mm from the apex, while in control they appear at that of 13.7 mm. Since the root under pressure does not elongate at all practically, their cells at a certain distance from the apex are far older than those of the control root placed much further from the apex. The advance of the differentiation seen in the cells of the root under pressure is therefore not to be regarded as the acceleration of growth; on the contrary, it really means a more or less long delay caused by the pressure.

**23. Zur Kenntnis des N-Gehaltes des Mykorrhizaknöllchens von *Podocarpus macrophylla* D. Don (Japanisch).** Takeo KONDO. (Bot. Mag. Tōkyō 45, 1931, 495–501).

Bei den frischen jungen sowie alten Mykorrhizaknöllchen und den jungen Wurzeln von *Podocarpus macrophylla* wurde die N-Gehaltbestimmung mittelst der Mikro-KJELDAHL-Methode von PREGL ausgeführt, und damit wurde die Menge des Eiweiss- und des übrigen Stickstoffes bestimmt. Dabei ergab es sich, dass bei alten Knöllchen die im Lösungszustand befindlichen Amid-, Amino- und Ammoniakstickstoffe erheblich weniger vertreten sind als bei den jungen Knöllchen sowie den jungen Wurzeln. Woraus kann man sehen, dass in den jungen Knöllchen eine relativ grosse Menge des Stickstoffes in der leicht transportablen Gestalt aufgespeichert wird.

**24. Studien über die Erkennung der Drogen auf Grund des Aschenbildes (II. Mitteilung). Aschenbilder wichtiger, in den japanischen, deutschen und österreichischen Pharmakopöen fehlender Drogenblätter.** (Japanisch m. deutsch. Zfg.). Yosio KONDO. (Jour. Pharm. Soc. Japan No. 597, 1931, 124–130, 913–934, 3 Taf. u. 7 Textabb.).

20 Arten von Drogenblättern wurden untersucht, welche zu den Compositen, Solanaceen, Labiataen, Rutaceen, Rosaceen usw. gehören. Unter den Strukturelementen im Aschenbild sind die Kalkoxalatkrystalle die hauptsächlichsten; sie kommen als monokline Einzelkrystalle, Drusen, Raphiden, tetragonale Krystalle und Krystallsand. Die anderen Strukturelemente sind z. B. die Plastiden, verkieselte Haare, Ölräume, Aschenskelette der Epidermis- und Schwammparenchymzellen. Ein Schlüssel zur Bestimmung der untersuchten Drogenblätter auf Grund solcher Strukturelemente wird angegeben.

**25. Die Beziehungen zwischen den verschiedenen physiologischen Erscheinungen der Pflanzen und den an verschiedenen Vegetationsorganen in Erscheinung tretenden Farbstoffen. III. Mitteilung. Über die Beziehungen zwischen der Wachstumstätigkeit und der Anthocyanbildung bei *Abutilon Avicennae*.** Hiroshi KOSAKA. (Jour. Dpt. Agric., Kyūshū Imp. Univ. 3, 1931, 99–119).

Bei den Keimlingen von *Abutilon Avicennae*, wobei die Anthocyanbildung ohne Begleitung der merkbaren Assimilationstätigkeit stattfindet, ist es leicht nachweisbar, dass die Lebhaftigkeit dieses Vorganges sich der Intensität des Längenwachstums umgekehrt verhält. Diese Tatsache kann man leicht begreifen, wenn man den Verbrauch der Nährstoffe und Baustoffe bei jedem von zwei obengenannten Vorgängen bedenkt. Bei den weiter in ihrer Entwicklung fortgeschrittenen Pflanzen ist die im obigen genannte Beziehung nicht so klar festzustellen, was auf viel grössere Herstellung von Assimilaten durch die soweit entwickelten Pflanzen zurückzuführen sein dürfte, sodass wenn man diese Herstellung verhindert, z.B. durch das Abpflücken der Blätter, kann man klar diese Beziehung feststellen.

**26. Materials for a flora of Formosa III-VI.** (With Japanese résumé). Yushun KUDO. (Jour. Soc. Trop. Agric. **3**, 1931, 16-19, 110-112, 225-227, 386-391).

A number of Formosan Plants are enumerated, of which the following are new and described: *Liparis Tateishii*, *Isodon koroensis*, *Ajuga Matsumurana*, *Perilla Shimadae*, *Salvia Matsudae*, *Suzukia luchuensis*. For *Amentotaxis argotaenia* PILGER a new family, Amentotaxaceae is established; it was placed heretofore under the family Cephalotaxaceae.

**27. Über eine Methode, um die Tatsache nachzuweisen, ob *Piricularia Oryzae* noch lebt oder nicht.** (Japanisch). Kazue KURIBAYASHI. (Jour. Plant Prot. **17**, 1931, 11 pp.).

Für den im obigen Titel genannten Zweck verwendet der Verf. eine Mischung gleicher Menge von 2% Neutralrot- und Methylblaulösungen. Wenn man die Konidien von *Piricularia Oryzae* mit dieser Farbstoffmischung behandelt, sieht man bei den lebenden eine grosse Anzahl von tiefrot- oder orangegefärbten kugeligen Körner verschiedener Grösse, während bei den abgestorbenen der ganze Körper binnen 5 Minuten total dunkelgrün gefärbt wird. Diese Methode ist für den Versuch an den Myzelien unbrauchbar. Es ist weiter hinzuzufügen, dass sie für den gewissen anderen Pilze mit Erfolg benutzt werden kann, z. B. *Colleotrichum Lindemuthianum*, *Cercospora beticola*, *Lisea Fujikuroi* usw.

**28. Effect of temperature and medium upon the overgrowth phenomenon of rice seedlings caused by the excretion of the cultures of *Lisea Fujikuroi* Saw.** (Japanese). Eiichi KUROSAWA. (Jour. Nat. Hist. Soc. Formosa **21**, 1931, 159-181.).

It is well known that the filtrate of the culture solution of *Lisea Fujikuroi*, the causal fungus of the "Bakanae"-disease of rice-plants, induces the abnormal overgrowth of length of their seedlings, as though they were attacked by this fungus itself. In some cases, however, the opposite phenomenon, i.e. the checking of length growth was observed.

The author made the culture of this fungus in certain agar nutrient media, and studied the effect of the filtrate of such nutrient solutions on the growth of rice seedlings under various temperatures. It was found that the overgrowth occurs within 20-35°, 20° being the optimum, and that above 35° the checking action sets in. For the latter action the presence of potassium or calcium nitrate and grape-sugar in the



culture solution is necessary, while for the overgrowth in addition to the two above substances acid potassium phosphate must be present. As in both cases, i.e. overgrowth as well as checking of growth the solution contains certain substances in common, it was sometimes observed that the solution for the overgrowth induces the checking.

**29. Contribution to our knowledge of the flora of the southern part of Japan. IV-VII.** (With Japanese résumé). Genkei MASAMUNE. (Jour. Soc. Trop. Agric. **3**, 1931, 20-23, 113-116, 246-247, 392-394).

The following new species are described: *Oreomyrrhis gracilis*, *Veronica tsugitakensis*, *Tricyrtis Suzukii*, *Polygala Simadai*, *Botryopleuron formosanum*, *Fragaria yakusimensis*, *Japanobotrychum* (a new genus belonging to the Ophioglossaceae) *arisanensis*, *Geranium Suzukii*, *Zeuxine yakusimensis*, *Oldenlandia yakusimensis*.

**30. On the causal organism of the bacterial soft rot of "kotyôran," Phaelaenopsis Aphrodite REICHENB. f.** (With Japanese résumé). Takashi MATSUMOTO and Norio OKABE. (Jour. Soc. Trop. Agric. **3**, 1931, 117-134, 1 pl. and 3 text-figs.).

The soft rot disease of the ornamental Formosan orchid, *Phaelaenopsis Aphrodite* (Japanese name, "kotyôran") is caused by an organism closely related to *Bacillus caratovoratus* JONES, which the authors call the type B to distinguish it from that which they obtained and which they call the type A. They performed the culture of the latter on various nutrient media. The organism grows best under slightly alkaline reaction within 15-42°C, 27-34° being the optimum. Exposure to midday sunlight leads to 90-100% death within 10 minutes. Positive results were obtained in tests of ammonia, reduction of nitrate, gas- and acid-formation in carbohydrate media, hydrogen sulphide, diastase, pectinase and liquefaction of gelatine, and also in slight indol reaction. Negative by GRAM's stain. Serologically the organism is closely related to Nos. 403 and 207, as well as to 208 and 209.

**31. Immunological studies of mosaic diseases. I. Effect of formalization, tryptsinization and heat-inactivation of tobacco mosaic juice. Part I-II.** (With Japanese résumé). Takashi MATSUMOTO and Kôetsu SOMAZAWA. (Jour. Soc. Trop. Agric. **2**, 1930, 223-234; **3**, 1931, 24-33).

When tobacco mosaic juice is treated with 2% formalin during 48 hours, its precipinogenic activity was lessened somewhat in its strength, and this treatment makes also the mosaic juice less reactive in precipitating with antisera, though these two properties are not wholly destroyed. The infectious principle of the disease was on the contrary perfectly inactivated by this treatment. Almost the same result was obtained in the complement fixation test.

The antigenic property of mosaic juice treated with 2% trypsin during 24-48 hours remains intact. Even in the mosaic juice treated with 2% trypsin during 72-96 hours or treated with 5% or 10% trypsin during 48 hours the precipinogenic property is almost equal to that of untreated mosaic juice. This fact holds true also in respect to the complement fixation test.

In order to study the action of heat on the mosaic juice it was subjected at first to the temperature of 90°C during 2 minutes, and it was found that the precipinogenic



activity of the supernatant liquid was almost equal to that of normal juice. If the duration of treatment became prolonged, the reaction began to decrease rapidly. If the heating will continue during 10 minutes the supernatant liquid loses wholly its antigenic property, and no production of antibody takes place, when it is injected into rabbits. In respect to the compliment fixation test, the mosaic juice subjected to 80°C during 5 or 10 minutes, as well as that subjected to 90°C during 2 minutes reacted to much higher titres than did the untreated.

The virulicidal action of the antisera prepared from tobacco mosaic juice against the infection agency was inactivated by formalization, trypsinization or heating. As the precipitating as well as the complement fixation reactions are not destroyed by formalization as above stated, the authors think that the substance concerned in these processes might be different from the virulicidal antibody.

**32. Icones of the essential forest trees of Hokkaido.** Kingo MIYABE and Yushun KUDO. **2**, fasc. 19-20; **3**, fasc. 21-28, 1928-1931. Publ. by the Hokkaido Government. 28 coloured pls. with explanations in Japanese and English.

The following plants are contained: 2 sp. *Prunus*, *Maackia*, *Phellodendron*, *Picrasma*, 2 sp. *Rhus*, *Ilex*, 2 sp. *Evonymus*, 8 sp. *Acer*, *Aesculus*, *Rhamnus*, 2 sp. *Tilia*, 2 sp. *Kalopanax*, *Aralia*, *Cornus*, 2 sp. *Styrax*, 2 sp. *Fraxinus*, *Syringa*.

The "Icones" is now complete; it contains 86 plates in all.

**33. Flora of Hokkaido and Saghalien II.** Kingo MIYABE and Yushun KUDO. (Jour. Fac. Agric. Hokkaido Imp. Univ. **26**, 1931, 81-277, 1 pl. and 1 text-fig.).

This part contains Nos. 127-535, and includes the following families: Typhaceae, Sparganiaceae, Potamogetonaceae, Najadaceae, Scheuchzeriaceae, Alismataceae, Hydrocharitaceae, Gramineae (Bambuseae by T. NAKAI) and Cyperaceae.

Besides several new species which are generally described a new genus *Sasamorpha* is established by NAKAI; it is nearest to *Sasa* and *Pseudosasa*.

**34. On the conjugation of the gametes and the development of the zoospores in Ulvaceae.** Kiichi MIYAKE and Hiroshi KUNIEDA. (Jour. Coll. Agric. Imp. Univ. Tokyo **11**, 1931, 341-357, 4 pls.).

Both *Monostroma* and *Enteromorpha* are strictly dioecious, as proven experimentally by the authors. The gametes are slender and biciliate; the conjugation of male and female gametes was observed. In *Enteromorpha* the zoospore is much larger than the gamete and 4-ciliate. In *Ulva* both gametes and zoospores were seen, though the conjugation of gametes was not observed. The zoospore is much larger than the gamete and biciliate, but not 4-ciliate, as previously reported.

**35. Interspecific hybridization in Brassica IV. The cytology of F<sub>1</sub> hybrids of *B. carinata* and some other species with 10 chromosomes.** T. MORINAGA. (Cytologia **3**, 1931, 77-83, 12 text-figs.).

In F<sub>1</sub> hybrid, *Brassica chinensis* × *B. carinata* (Abyssinian mustard) the somatic nuclear division, as examined in root-tip cells, is quite normal. In the heterotype

pivision of the pollen mother-cells both univalents and bivalents are present, the number of the former varying between 9 and 25. The bivalents are easily distinguishable from univalents on account of their stretched form. The univalents have a tendency to come up tardily to the equator; each of them splits up longitudinally, and the two halves thus formed travel generally towards the opposite poles. In the homo-type metaphase the chromosomes arrange themselves regularly on the equatorial plane with few exceptions. Some irregularities were observed. The heterotypic division was suppressed so as to form one large nucleus with the whole number of chromosomes. In another case the heterotypic spindles come to fusion and give rise to dyads. In still another case triads are formed by the union of three chromosomes groups out of four into one.

**36. Preliminary report on the haploid plant of rice, *Oryza sativa*, L.** Toshitaro MORINAGA and Eiji FUKUSHIMA. (Proc. Imp. Acad. **7**, 1931, 383-384, 3 figs.).

Though a great number of rice strains were studied heretofore by several authors concerning the chromosome number, the result was invariably  $n = 12$ ,  $2n = 24$ .

The authors of this paper have performed in 1930 the crossing of two Japanese rice varieties., Dekiyama ♀ × Bunketutô ♂. Of 13 offspring produced by this crossing 12 were perfectly fertile and evidently the hybrids, as may be seen from their morphological characters. The remaining one which was highly sterile was externally quite similar to the mother plant, though reduced in size. The authors came to the idea that it might be a haploid plant. Since it was then too late to study the sporogenesis, the plant was placed in a greenhouse, and the roots newly produced were examined. It was observed that its cell contains 12 chromosomes, thus the haploid nature of the plant was duly proven.

**37. On new species of the genera *Cinnamomum* and *Smilax* from the miocene deposits of Oguni-machi, Uzen province, Japan.** Hikoji MORITA. (Japanese Jour. Geol. & Geogr. **9**, 1931, 1-8, 2 pls.).

The Neogene plant beds exposed in Ogunimati, Nisi-Okitamagun, Uzen province are very rich in plant remains. They are enumerated, and the following new species are described: *Cinnamomum miocenum*, *C. oguniense*, *Smilax trinervis*, *S. minor*.

**38. *Yoania amagiensis* NAKAI & F. MAEKAWA, a new species of *Yoania*.** Takenoshin NAKAI and Fumio MAEKAWA. (Proc. Imp. Acad. **7**, 1931, 319-322, 2 text-figs.).

A Latin description of the new species above noticed.

**39. Über die Hartschaligkeit und die Quellung der Samen von *Astragalus sinicus*, L. I-II.** (Japanisch). Yôzô NAKAJIMA. (Bot. Mag. Tôkyô **45**, 1931, 555-566 mit vielen Tabellen).

Der Verf. hat die Quellung der durch ihre Hartschaligkeit bekannten Samen von *Astragalus sinicus* untersucht. Nach den Resultaten des Verfs. Beobachtungen, welche während fünfzehn Jahren fortgesetzt worden sind, wurde es festgestellt, dass

jedes Jahr die Quellung am üppigsten im September-Oktober geschieht. Diese Tatsache ist nach den Verfs. Ansicht darin gegründet, dass in diesen Monaten die Minimum-Temperatur im Laboratorium unter 20°C kommt und solche Temperatur die Quellung besonders beschleunigt.

Die obigen Experimente sind auf die Quellung der Samen beschränkt. Der Verf. hat auch ihre Keimung untersucht und die den bei den Versuchen über die Quellung gleichartigen Resultate bekommen.

Weiter hat der Verf. die Experimente der Samenquellung unter verschiedenen äusseren Bedingungen untersucht, worüber auf das Original verwiesen sei.

**40. Karyological studies on the genus *Rhododendron*.** (With Japanese résumé). Miyawo NAKAMURA. (Jour. Soc. Trop. Agric. 3, 1931, 103-109, 1 pl.).

The author has counted the chromosome number in the pollen mother-cells of a certain number of *Rhododendron* species, and found its 13. The chromosome behaviour during the nuclear division is quite normal, except a few cases of its lagging. The author comes to the conclusion that more than 20% of the Japanese *Rhododendron* species are diploid with 13 as the basic number. Some discussion on the classification of *Rhododendron* ends the paper.

**41. Zytologische Beobachtungen über zwei Sippen steriler Reispflanzen.** (Japanese). Seisuke NAKAMURA. (Proc. Crop Sc. Soc. Japan 3, 1931, 259-265).

Bei einer Sippe steriler Reispflanzen beobachtet man 70% sterile Körner und zugleich 4% parthenokarpische. Der Pollenbildungsvorgang geht ganz normal, und fast alle Pollenkörner sind keimungsfähig. Ebenso sind alle fast Samenanlagen mit normalen Embryosäcken versehen. Die Ursache der Sterilität bei dieser Sippe muss somit von der physiologischer Natur sein.

Bei einer anderen Sippe beträgt die Sterilität 58%. Man hat dabei beobachtet die Aufspaltung zu fertilen und sterilen Nachkommen im gleichen Verhältnisse; die ersteren sind konstant, während die letzteren wieder gleicherweise aufspalten werden. Die zytologischen Studien haben gezeigt, dass bei dieser sterilen Sippe sowohl der Pollen als der Embryosack der Degeneration unterworfen sind, und zwar ungefähr zu 50%.

**42. Hybridization between Old World and New World cotton species and the chromosome behavior of the pollen mother-cells in the F<sub>1</sub>-hybrid.** Sadao NAKATOMI. (Japan. Jour. Bot. 5, 1931, 371-383, 1 pl. and 7 text-figs.).

**43. The genetics and cytology of certain cereals. II. Karyogenetic studies of fatuoid oats with special reference to their origin.** Ichizo NISHIYAMA. (Japan. Jour. Gen. 7, 1931, 49-102, 2 pls. and 36 text-figs.).

The author found that heterozygous fatuoids from three strains called H<sub>58</sub>, H<sub>20</sub> and H<sub>93</sub> give normals: hetero-: homozygous fatuoids in 1:2:1 ratio, which confirms the statement made previously by HUSKINS. The cytological examination has revealed the fact that the pollen mother-cells in the segregates show generally 21 normal bivalents with rare exceptions, when uni-, tri- and tetravalents were seen. The author thinks that meiotic abnormalities are independent of the phaenotypic character



of the grain, and not transmissible from generation to generation. Few plants with 41 chromosomes were found, which might have been produced owing to the meiotic irregularities. From the latter are derived dwarf homozygous fatuoids, heterozygous fatuoids and normals in 1:1,5:0,1 ratio. Among these offspring the first ones show 40 somatic chromosomes, but since the number of bivalents is much reduced, they are quite sterile though few fertiles are found. Heterozygous fatuoids with  $20_{II}+1_I$  are various in their fertility. Normals are quite normal. As to the origin of the fatuoids, the author thinks that firstly they may be due to a gene mutation in a certain chromosome, and secondly to chromosome aberration. Its origin by natural crossing seems improbable according to the author.

**44. Vergleichende Untersuchungen über die durch *Lisea Fujikuroi* SAW. und *Gibberella moniliformis* (SH.) WIENEL. verursachten Gramineenkrankheiten.** Yosikazu NISIKADO. (Ber. Ôhara Inst. landw. Forsch. 5, 1931, 87-106, 4 Taf.).

Impfungsversuche an Reis- bzw. Maiskeimlingen mit *Lisea Fujikuroi* SAW. und *Gibberella moniliformis* (SH.) WIENEL. wurden ausgeführt. Nach den Resultaten solcher Versuche wurde es festgestellt, dass *Lisea Fujikuroi*, der Erreger der sog. "Bakanae"-Krankheit von Reis sowie *Fusarium moniliforme* SH. v. *majus* WR. et RG., der Erreger der "Pokkah boeng"-Krankheit des Rohrzuckers, eine Keimlingshypertrophie oder sog. "Bakanae"-Reaktion hervorruft, während weder ein von Zuckerrohr isolierter Stamm von *Fusarium moniliforme* v. *majus* noch ein von Mais isolierter amerikanischer Stamm von *Fusarium moniliforme*, das Nebenfruchtform von *Gibberella moniliforme* keine solche Kraft besitzt. Auf die Resultate seiner oben zitierten physiologisch-pathologischen Untersuchungen gestützt, kommt der Verf. in Uebereinstimmung mit WOLLENWEBER zu der Ansicht, dass *Fusarium moniliforme* v. *majus* WR. et RG. die Konidienform von *Lisea Fujikuroi* SAW. ist und somit die letztere als *Gibberella Fujikuroi* (SAW.) WR. bezeichnet werden muss und doch von *G. moniliformis* (SH.) WIENEL scharf zu trennen ist.

**45. Beiträge zur physiologischen Spezialisierung einiger obstbewohnenden Fusarien.** Yosikazu NISIKADO. (Ber. Ôhara Inst. landw. Forsch. 5, 1931, 107-144, 4 Taf.).

Betreffs verschiedene Formenkreise von *Fusarium lateritium* und einige von *F. oxysporium* hat der Verf. die Kulturversuche auf verschiedene Nährböden sowie die Impfversuche an einigen Obstarten ausgeführt und zugleich auch dabei den Einfluss der Temperatur auf die Entwicklung studiert.

Die Resultate aller solchen Versuche haben den Verf. zu den in mancher Hinsicht mit denen von BROWN und seinen Mitarbeitern an den Stämmen von *F. fructigenum* (= *F. lateritium* v. *fructigenum*) gemachten Studien übereinstimmenden Schlüssen geführt, wenn einige Abweichungen vorhanden sind, 1. dass diese Stämme in vier Gruppen klassifiziert werden können, nämlich, Myzel-, Sporodochien-, Pinnotes- und Langsporettyp und 2. dass die Pathogenität sich in der oben angegebenen Reihenfolge vermindert.

**46. Über die Korrelation zwischen der Keimungsfähigkeit der Maispollenkörner und den äusseren Faktoren.** (Japanisch). Koi NODA. (Proc. Crop Sc. Soc. Japan 3, 1931, 142-157, 3 Textabb.).



Eine Anzahl von Experimenten über die Keimung der Maispollenkörner auf den künstlichen Medien (Zuckeragar von bestimmter Konzentration und pH) wurden ausgeführt, und zwar mit besonderer Berücksichtigung auf die Temperatur und Feuchtigkeit, woraus der Verf. zu den folgenden Schlüssen gelangt ist. Die Optimumtemperatur für die Keimung ist nach den Sippen verschieden; keine Beziehung zwischen der Keimung und dem Lichte ist nachweisbar. Die Keimung nimmt mit der Zunahme der Temperatur und Feuchtigkeit allmählich ab, so z.B. bei der Sippe Longfellow beträgt der Korrelationskoeffizient zwischen der Temperatur und der Keimung  $-0,85$ , während bei der Sippe "Kôsyû" derselbe zwischen der Feuchtigkeit und der Keimung  $-0,45$  beträgt. Der Nährboden, welcher 10% Zucker und 0,7% Agar enthält, hat sich immer bestens für die Keimung erwiesen.

**47. On a fossil tree stem from the upper cretaceous of Iwaki, Japan.** Yudzuru OGURA. (Japan. Jour. Geol. & Geogr. **9**, 1931, 55-60, 1 pl and 1 text-fig.).

A new species *Protocyathea Tokunagai* from lower senonian in upper cretaceous is described. The determination is based on two specimens of the stem densely covered with leaf scars.

**48. Symbolae ad floram Asiae orientalis III.** Jisaburo OHWI. (Bot. Mag. Tôkyô **45**, 1931, 377-389, 1 text-fig.).

The following new species are described: *Fimbristylis Tashiroana*, *Hystria sachalinensis*, *Puccinellia nipponica*, *P. adpressa*, *Glyceria leptolepis*, *G. depauperata*, *G. infirma*, *Neottia subsessilis*, *Disporum ovale*, *Isachne Fauriei*, *Adlumia asiatica*, *Anemone Tagawae*.

**49. Sex in *Stropharia semiglobata*.** Kôhei ÔIKAWA. (Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. **6**, 1931, 391-395).

Cf. Japan. Jour. Bot. **5**, (105), Nr. 346.

**50. Study of *Euryale ferox* SALISB. VII. Change of catalase and germination percent during the after-ripening of the seeds.** Yonosuke OKADA. (Sc. Rpts., Tôhoku Imp. Univ. IV. Ser. **6**, 1931, 429-436).

The seeds of *Euryale ferox* freed from fruit debris, etc. were stratified in mud in shallow water-tight pots of porcelain, which was always full of water. They were studied nearly every six months concerning their catalase activity and germination power. It was found that catalase is far more dense in the embryo (plus very thin endosperm) than in perisperm. During the period of germination the germination percent was found to decrease, and then to increase, while the catalase activity was always observed to decrease during the same period, so that no direct correlation was discernible between the two processes.

**51. Physiological studies on *Drosera* III. The effect of various acids on the digestion of protein by pepsin.** Kunio OKAHARA. (Sc. Rpts. Tôhoku Imp. Univ. IV. Ser. **6**, 1931, 573-595).

Formerly (cf. Japan. Jour. Bot. **5**, (72), 248) the author has detected in the leaves of *Drosera* the proteolytic enzyme closely resembling pepsin as well as formic acid. In connection with these observations he reported in the present paper the results of his studies on the effect of various acids on the enzyme.

The author examined the digestion of edestin solution by pepsin at 39°C with the addition of certain acids, inorganic as well as organic, such as HCl, formic, acetic, propionic, butyric, etc., etc. It was firstly found that the optimum pH for the digestion by pepsin differs in different kinds of acids taken into use. Thus, for instance, it is 1.8-1.9 for HCl and malleic acid, 2.6 for malonic and citric acid, 3.0 for acetic acid, etc., etc. For the explanation of the above fact the author makes the following assumption: since the acidification of the protein solution with the acids of different kinds results in the formation of the protein-acid-compounds of different kinds, the optimum pH for their digestion must necessarily vary with different kinds of these compounds, whence the difference just stated.

Further, it was observed that the decrease in the optimum pH for digestion goes parallel generally with that of the electric dissociation constants of the acid used, thus, for instance, when we compare sulfuric, nitric, phosphoric, malleic acids with very large dissociation constants on one hand, and the fatty series acids, as acetic, butyric, propionic acids with smaller dissociation constants ( $1.4-1.8 \times 10^{-5}$ ) on the other, we see that the optimum pH measures 1.6-2.00 in the former and 2.9-3 in the latter.

**52. Über die Beeinflussung des Wachstums der Schimmelpilze durch die von Rosahefen gebildeten Stoffe.** Kazuo OKUNUKI. (Japan. Jour. Bot. **5** 1931, 401-456, 1 pl. und 6 text-figs.).

**53. On drought resistance, morphological and physiological modifications and variations of yields for various soil moisture contents in rice-plant.** (Japanese with English résumé). Jiro ONODERA. (Proc. Crop Sc. Soc. Japan **2**, 1931, 91-116).

Comparative culture studies of low- and upland rice plants have led the author to the following conclusions.

By scanty water-supply the yield decreases, and in this respect the height of culm of the upland rice is much less influenced than that of lowland one. It is the same with the influence of various soil moistures on the mean weight of panicles, inasmuch as the decrease of the latter is much less in upland than in lowland rice. The development of stereoms under drought condition is on the contrary much greater in lowland than in upland rice. Though the decrease of soil moisture causes the change of osmotic pressure of cell-sap as well as pressed plant-juice, this is not so conspicuous in upland rice, when the decrease of soil moisture is slight, while lowland rice is more sensible in this respect.

**54. Systematic and anatomical studies on the Japanese Juncaceae (2).** (Japanese). Yoshisuke SATAKE. (Bot. Mag. Tôkyô **45**, 1931, 446-453, 7 text-figs.).

In the Juncaceae the seed-coat which is derived from the inner integument of the ovule is superficially provided with a network. There are five kinds of networks

according to the author, viz. 1. hexagonal network, somewhat elongated in the direction of the long axis, 2. the same as in 1, but besides with a series of cross striations, 3. rectangular networks, somewhat elongated in the direction of long axis, 4. hexagonal network, elongated in the direction of transverse axis, the opposite angles at left and right sides being acute, and 5. the same as in 4, but the network is much smaller, the opposite angles being larger than  $90^\circ$ . The author gives a key for the determination of the Japanese Juncaceae according to the character of seeds, and primarily on the basis of the kinds of networks above mentioned.

**55. Systematic and anatomical studies on some Japanese plants I.** Yoshisuke SATAKE. (Jour. Fac. Sc. Imp. Univ. Tokyo, Sec. III. **3**, 1931, 485-513).

This paper refers to the classification of the Urticales according to their spodograms. The paper gives the description and key of the Ulmaceae, Moraceae, Urticaceae. It contains besides the systematic anatomy of *Hakonechloa macra* MAKINO newly created. The latter was originally included among the genus *Phragmites*. According to the author there are several differences in the epidermal structure, which distinguish *Hakonechloa* from *Phragmites* and justify the creation of this new genus.

**56. Systematische Bedeutung der Zahlenverhältnisse der Zapfen bei einigen Nadelhölzern.** (Japanisch). Keizi SATÔ. (Zeit. dendrol. Ges. **13**, 1931, 691-732, 15 Textabb.).

Der Verf. hat bei einigen japanischen Lokalsippen von *Cryptomeria japonica*, *Chamaecyparis obtusa*, eine *Pinus*art (Sirahatamatu) usw. die Länge und Durchmesser ihrer Zapfen studiert, um die Resultate davon für systematische Zweck benutzen zu können. Wenn bisher die Länge und Durchmesser der Zapfen oftmals für die Klassifikation benutzt worden sind, sind sie so stark variabel, dass sie für diesen Zweck keineswegs brauchbar sind. Dagegen besteht zwischen der Länge und Breite der Zapfen jedes Individuums eine hohe positive Korrelation, und das Zahlenverhältnis zwischen ihnen ist für den Zweck der Klassifikation gut brauchbar. Dies Zahlenverhältnis ist nämlich ungefähr konstant in irgend einem Zapfen, welcher sich an verschiedenen Zweigen eines Baumes befindet, und dabei ist die absolute Grösse der Zapfen ganz irrelevant. Um einige Beispiele dieser Zahlenverhältnisse zu zitieren, haben wir *Cryptomeria japonica*, vorderjapanische Sippe  $1,04 \pm 0,07$ , dieselbe Art, hinterjapanische Sippe  $0,93 \pm 0,07$ , *Chamaecyparis obtusa*, Kyôtosippe  $1,07 \pm 0,07$ , dieselbe, Kôyasippe  $1,00 \pm 0,06$  usw.

**57. Botanische Studien von Sirahatakiefer mit besonderer Berücksichtigung des anatomischen Baues der Blätter.** (Japanisch). Keizi SATÔ. (Bull. Tokyo Imp. Univ. Forests **15**, 1931, 167 S., 15 Taf., 37 Textabb. und viele Tab.).

"Sirahatakiefer" ist eine forstliche Rasse, welche im gewissen Gegend von Nordostjapan seit langem kultiviert worden ist. Sie ist durch die Zähigkeit gegen Kälte, schnelles Wachstum und die Widerstandsfähigkeit gegen verschiedene Schaden ausgezeichnet. Ihre Hölzer sind forstlich sehr brauchbar. Diese Rasse scheint systematisch *Pinus densiflora*  $\times$  *P. Thunbergii* zu nähern. Betreffs diese Rasse be-



schreibt der Verf. ausführlich verschiedene Merkmale, z. B. die Rindenfarbe, Winterknospen, Nadeln, Zapfen, Samen usw. Dann folgt eine ausführliche Beschreibung der anatomischen Merkmale der Nadeln und ihrer Variationen. Es ist kaum möglich, alle diese einzelne Tatsache in diesem kurzen Auszug zu zitieren. Nur sei es erwähnt, dass der Längenunterschied der Nadeln jedes Blattpaares 0-2 mm beträgt; der Fall, wobei sie gleichlang sind, und derselbe, wobei sie ungleichlang sind, sind im allgemeinen im Verhältnis 4:6, wenn auch dies Verhältnis von 1:9 bis zu 9:1 variieren kann.

**58. Materials of the Formosan fungi (28).** (Japanese). Kanekichi SAWADA. (Trans. Nat. Hist. Soc. Formosa **21**, 1931, 227-235).

Continuation of the author's study on Formosan fungi. The following species are new and described: *Mitremyces formosana*, *Ramularia citrifolia*, *Hemileia Gardiniae-floridae*, *Septoria Ranunculi-Vernyi*.

**59. List of fungi found in Formosa.** Kanekichi SAWADA. Published by the Research Institute of the Formosan Government, 1931, 103 pp.

This booklet enumerates all the names of fungi found in Formosa till June 1931; Eumycetes pp. 1-26, Myxomycetes pp. 27-32. Latin names are arranged in alphabetical order. Host index pp. 33-92, index of Japanese name pp. 93-103.

**60. A note on the mitotic division in the proembryo of *Ginkgo*, with special reference to a chromatin-elimination.** (Japanese with English résumé). Tamaki SHIMAMURA. (Bot. Mag. Tôkyô, **45**, 1931, 525-530, 1 pl. and 2 figure-groups).

During successive nuclear divisions in the proembryo formation of *Ginkgo biloba* the size of the nucleus decreases division after division, thus e.g. while the fusion nucleus measures 85-100  $\mu$  in diameter, the nucleus after the seventh division measures 20-25  $\mu$  only. This decrease of nuclear size is evidently closely related to the chromatin-elimination which occurs in early developmental stage, when the nuclei are yet of huge dimension; thus the author could observe this phenomenon up to 32-nucleate stage. The chromatin-elimination takes place as follows: during the nuclear division deeply staining basophilic granules are found scattered among the spirem thread; when the chromosomes form the equatorial plate, the granules are scattered mostly towards both poles; they form then larger masses of less basophilic nature, and finally disappear.

**61. Über die abnorme Reduktionsteilung in P.M.Z., die einen riesigen Kern oder überzählige Zweigkerne enthalten.** (Japanisch m. deutsch. Zfg.). Naomasa SHIMOTOMAI. (Bot. Mag. Tôkyô **45**, 1931, 356-363, 16 Textabb.).

Bei *Chrysanthemum ornatum* (= *C. Decaisneanum* var. *radiatum* f. *satsumensis*) sieht man oft abnorme Pollenmutterzellen, die schon bei der Prophase der Reduktionsteilung Riesenkerne oder überzählige Kerne enthalten, welche durch unregelmässige Kern- und Zellteilung in den Archiesporialzellen entstanden sein sollen. Infolgedessen treten in der heterotypischen Metaphase grosse oder kleine Kernplatten auf, ja sogar können mehrere Kernplatten in einer und derselben Pollenmutterzelle auf-



treten. Als die Chromosomen, die im kleinen Kerne oder verletzten Teile des riesigen Kernes enthalten sind, nicht genug verkürzen können, um in normaler Weise stäbchenförmig zu werden, sieht man oft fadenförmige Chromosomen in der metaphasischen Spindel. Die nahe liegenden Kernplatten können dann verreinigen, sodass die Tochterchromosomen nach je einem gemeinsamen Pol gehen.

Bei homöotypischen Kernteilung sieht man riesige Pollenmutterzellen, wobei zwei diploide Kernplatten regelmässig gebildet sind. Die Entstehung der diploiden riesigen Keimzellen ist nach der Autors Ansicht nicht dem Restitutionskern ROSENBERGS zu verdanken, sondern der abnormen Kern- und Zellteilung, welche im Archespor stattgefunden hat.

**62. A list of chromosome numbers in angiospermous plants.** Toranosuke SUGIURA. (Bot. Mag. Tôkyô 45, 1931, 353-355).

The haploid or diploid number of chromosomes in Angiosperms belonging to 60 families is given.

**63. Über den Einfluss der Tagesdauer über das Wachstum, Blühen und Fruchtbildung bei Buchweizen und Sojabohne.** (Japanisch). Kiyomitu TAHATA, Kyôhei OGATA und Kazuo SUKEKAWA. (Proc. Crop Sc. Soc. Japan 3, 1931, 188-202, 4 Taf.).

Die folgenden vierlei Kulturexperimente an Buchweizen und Sojabohne wurden ausgeführt: 1. Kultur unter natürlichen Bedingungen (Kontrolle), 2. und 3. dieselbe, wobei die Pflanzen 4 bzw. 8 Stunden pro Tag (d. h. vom 8 Uhr Morgen bis Mittag bzw. 4 Uhr Nachmittag) durch Sonnenlicht beleuchtet werden, und 4. dieselbe, wobei die Pflanzen den ganzen Tag durch Sonnenlicht und in der Nacht elektrisch beleuchtet werden.

Die Resultate dieser Experimente sind wie folgt; Durch nächtliche elektrische Beleuchtung werden das Längen- und Dickenwachstum des Stammes beschleunigt, wenn bei Sojabohne das letztere dem der Kontrolle nachsteht. Der Eintritt des Blühens wird bei (4) bedeutend verzögert, bei (2) und (3) etwas beschleunigt. Das totale Gewicht der Buchweizenernte nimmt bedeutend in (4) zu und in (2) und (3) ab, während das Gewicht der geernteten Körner grösser ist bei der Kontrolle als bei (2), (3) und (4). Bei Sojabohne ist das totale Gewicht der Pflanzen grösser bei Kontrolle als bei den anderen Kulturen. Durch elektrische Beleuchtung wird der Stamm weich und lang, und bei (2) und (3) wird er zwergig. Bei einer Sippe von Sojabohne hat die nächtliche elektrische Beleuchtung zur völligen Sterilität der Pflanzen geführt.

**64. Further reports of cytological and genetic investigations of *Rumex Acetosa* L. I. New chromosome and chromosome-fragments.** (Japanese with English résumé). Yô TAKENAKA. (Bot. Mag. Tôkyô 45, 1931, 475-489, 19 text-figs.).

The chromosomal formula of the intersexual plants of *Rumex Acetosa* is various. The author could distinguish the following six cases, viz.

Chromosome number 15:  $13a+X+Y$ ,  $11a+Y+2Y+y$ ,  $12a+X+Y+y$

Chromosome number 15+1f or 15+4f:  $12a+X+2Y+1f$  or  $12a+X+2Y+4f$

Chromosome number  $22:18a+2X+2Y$

$a$  = autosome,  $f$  = fragment,  $y$  =  $y$ -chromosome.

Chromosome fragment is probably derived from the lagging chromosome often seen during irregular nuclear division.  $y$ -chromosome is formed by the fusion of the two bifurcate unequal arms of the  $Y$ -chromosome, and seems according to the author to contribute to the determination of female sex.

**65. Further reports of the cytological investigations on the sterile plants.** (Japanese with English résumé). Y. TAKENAKA. (Jour. Tyôsen Nat. Hist. Soc.) No. 12, 1931, 17 pp. with text-figs.).

*Lycoris squamigera* which is highly sterile is considered to be an autotriploid plant. In the nucleus of its root-tip cell 27 chromosomes are present; they consist of 9 sets, each of which differs chiefly by their respective size. Each set contains three chromosomes. In the heterotype division of the pollen mother-cells irregularities occur, which are commonly found in triploid plants, as the presence of tri-, bi- and univalents.

In *Allium scorodoprasum* var. *vivipara* which is also highly sterile the meiosis of the pollen mother-cells is very irregular. The number of somatic chromosomes is 16. The plant is considered to be a hybrid.

The sterility of *Calystegia hederacea* is due to the variability of the chromosome number. The somatic number is either 22 or 23; quite the same number is seen also in homoecotypic division of the pollen mother-cells.

The chromosome number in the root-tip cells of *Daphne odora* and *D. odora* var. *marginata* is 27 and 28 respectively. The heterotype division in the pollen mother-cells is very irregular. The author thinks that *D. odora* is a triploid plant with  $3 \times 9$  chromosomes, and *D. odora* var. *marginata* a hypertriploid plant with  $3 \times 9 + 1$  chromosomes.

**66. Über die Vererbung der Samenhautfarbe bei *Sesamum indica*.** (Japanisch). Torao TEZIMA. (Proc. Crop Sc. Soc. Japan 3, 1921, 232-235).

Die Kreuzung zwischen den *Sesamum*sippen mit schwarzen und weissen Körnern gab die Nachkommen mit schwarzen, was die Dominanz der schwarzen über die weisse Farbe zeigt. Die Nachkommen der zweiten Generation enthält ausser schwarz und weiss noch eine Reihe von Zwischenfarben, z.B. braun, schwarzbraun, rotbraun, orange usw. usw. Wenn man alle diese letzteren Farben unter der Rubrik Zwischenfarbe zusammenfasst, so hat man schwarz: Zwischenfarbe: weiss = 27:36:1, was auf die trihybride Natur hindeutet. Die  $F_3$  Generation wurde auch untersucht.

**67. Cardinal temperatures of pea-wilt *Fusaria* in culture.** Kogo TOGASHI. (Japan. Jour. Bot. 5, 1931, 385-400, 1 text-fig.).

**68. Studies on the pathology of peach canker.** Kogo TOGASHI. (Bull. Imp. Coll. Agric. and Forestry, Morioko. No. 16, 1-178).

This is the third and conclusive paper of a series of studies on the dieback or canker disease of peach trees which are caused by two distinct fungi, a form of

*Leucostoma Persoonii* (NITSCH.) TOGASHI (Syn. *L. leucostoma* (PEERS.) TOGASHI, *Valsa leucostoma* (PEERS.) (FR.) and a form of *Valsa japonica* MIYABE et HEMMI.

In the leafy stage the temperature of the peach branch, if shaded by the leaves, fluctuates almost parallel to the surrounding air temperature, but in the dormant stage the departure of the former from the latter is conspicuously great, being influenced by the direct sun rays. The difference between the tree and the air temperature is more especially remarkable on the south than on the north side of the branch. The greatest difference between both temperatures was observed in the middle of February, the maximum tree temperature having been 25°C. on the south and 16°C. on the north side, while the air showed only 5°C. in maximum. When the tree temperature on the north side fluctuates below 0°C. that on the south side generally fluctuates above 0°C., and that on the south side rises higher and contrary to that temperature fall on the north side. When the tree shows on the north 8°C. or below being undercooled by the influence of the surrounding cold air it rises suddenly to 2°C. or above. The greatest difference between the temperatures on the north and south sides ever seen was 22.5°, or 24.5° higher than that of the air.

*L. Persoonii* is more thermophilic than *T. japonica*. *L. Persoonii* grows luxuriantly between 23° to 37°C., and the maximum and minimum for the growth are 5° and 37°C. respectively. The growth of *V. japonica* having the maximum and minimum at 32° and 5°C. respectively is conspicuous between 15° and 25°C. Considering the difference of the behavior of the two fungi in relation to the temperature fluctuations of the peach branch the following observations in the field may be reasonably explained. (a) In hot days the fungi can not thrive in the peach tissues, particularly on the sunny sides. (b) *L. Persoonii* develops prominently during comparatively warm days, while with the coming of cold weather the development of *V. japonica* becomes more conspicuous than *L. Persoonii*. (c) *L. Persoonii* is widely distribute in Japan every where peach trees are cultivated, while the distribution of *V. japonica* is limited to the northern part of Honshu and Hokkaido. (d) The affected area begins to enlarge in early spring, and it is especially conspicuous on the southern sides of the branch.

Considering the difference of temperature fluctuations in the tissues of the peach branch between the south and north side it is highly probable that the tissues on the south side are more tender, in other words less resistant to low temperatures than those on the north side. In the coldest days of mid-winter the tree temperature on the south side fluctuates at a probable freezing point of -5°C. for several hours. In one case rapid temperature fall took place twice on the south side, and at last it reached -16°C. After that the temperature rose to -5°C., the probable freezing point of the tissues on the south side, and this condition continued for several hours.

The following day time the temperature on the south side showed the maximum of 22°C. when the air indicated the maximum of 7°C. Such confused and rapid temperature change on the south side of the branch seems to influence most injuriously the constitutive tissues and is believed to be a probable cause of the sun-scald which was frequently observed on the southern sides of peach branch.

The active acidity of the cell contents in the inner cortex tissue of the peach branch, which has the most important relation to the fungous invasion, ranges from pH 4.4 to pH 5.8, which values indicate at the same time the extremes of H-ion concentration in the dermal tissues.



The maximum H-ion concentration for the growth of *L. Persoonii* is pH 2.3-2.5, and for that of *V. japonica* it is about pH 3.5. The favorable H-ion concentration for *L. Persoonii* and *V. japonica* is pH 4.6-6.5, and pH 5.1-7.0 respectively. The minimum for both fungi is pH 7.7. Taking into consideration these data shown by the parasites and their host tissues a conclusion may be drawn as the two fungi have suitable biological character to execute their parasitic life on the peach bark, especially in *L. Persoonii*.

When the infection of *L. Persoonii* or *V. japonica* occurs on peach trees the disease causes the gummosis and a large amount of gummy substance is exuded, while in the cases of wounds given aseptically, none at all or slight amounts of the gummy substance flow out from the wound surface. The pathological anatomy of the diseased branches shows that soon after the first attack of fungous infection the middle lamellae of the cells composing the dermal tissues and the cell contents turn into gummy substance. At the same time the gum pockets are formed between the medullary rays in the embryonic wood tissue, converting its cell-walls and cell-contents into gummy substances.

Both fungi secrete the following enzymes:—diastase, invertase, maltase, emulsin, hemicellulase, pectinase, and cellulase. Among these enzymes hemicellulase, pectinase, and cellulase are detected to be more vigorous in activity. The enzymes of *L. Persoonii* have a tendency to act more prominently at higher temperatures than those of *V. japonica*. The suitable temperature for the enzymic activities of *L. Persoonii* ranges from 30-40°C., and those of *V. japonica* from 25-40°C. Effects of H-ion concentration upon the enzymic activity of the fungi are rather variable, mainly owing to the kind of enzymes. As a whole, more suitable H-ion concentration for their activities ranges from pH 3.0 to pH 7.0.

Considering the characters of enzymes secreted by the fungi in relation to the chemical constituents of the tissues of peach branches the gumming process in the affected branches can be perfectly understood. Moreover, considering together the reaction of the enzymes to temperatures and H-ion concentrations, the temperature fluctuations of peach branches, and the active acidities of their tissues it leads to the conclusion that the gumming process can take place more readily during the more actively growing period of peach trees.

The formation of wound periderm and the gumming process in the affected peach branch, forming the gum barriers and gum pockets are considered as principal protective measures against the invasion of the external injurious agencies. The advance of these processes seems to depend on the growing condition of the tree, and also on the stage of its growth when the infection took place. Practically the infection of the fungi occurs severely at the season from the middle of August to the first ten days of November in the districts about Morioka.

Author.

**69. A karyological study on the triploid hybrid of the genus *Celosia*. (Preliminary report).** (Japanese with English résumé). Shunjirô WAKAKUWA. (Japan. Jour. Gen. 7, 1931, 17-23, 16 text-figs.).

The cytological study of the pollen mother-cells of the triploid plant formed by the artificial crossing *Celosia argentea* ♀ ( $n = 36$ ) × *C. cristata* ♂ ( $n = 18$ ) was studied. At the metaphase of the heterotype division all bivalents arrange regularly in



the equatorial plane, while univalents are found generally at some distance from the plate. At the anaphase the univalents are distributed at random towards both poles, and do not undergo longitudinal splitting. The chromosome lagging is often observed in the interkinesis, and also in the second division. At the metaphase of the second division all dyad chromosomes arrange regularly in each of the two daughter nuclear plates. In the majority of cases quadruplet pollen-grains are formed, but sometimes quintuplets, and very rarely sextuplets. The karyological behaviour of this hybrid is therefore very similar to that of *Drosera* studied by ROSENBERG.

**70. Contributions to the cytology of fungi. III. Chromosome number in *Aspergillus*.** K. WAKAYAMA. (Cytologia 2, 1931, 291-301, 53 text-figs.).

The author has examined the nuclear division during the conidiospore formation on the sterigmata of 13 species of *Aspergillus*, inc. *A. niger*, *awamori*, *albus*, *aureus*, etc. In all species examined the karyological process was found to agree very closely. The sterigma is uninucleate, and the nuclear division goes there in equational or vegetative way with no complicated mitotic process, which confirms the current view that the conidiospores are asexual reproductive organs. The resting nucleus contains one large stainable body, the caryosome. When the division begins, the latter produces small roundish chromosomes and a centrosome. The haploid number of chromosomes is always two. The nuclear spindle is often of intranuclear origin, and shows a centrosome at each pole. The mitosis is quite normal, and each chromosome divides into two, whereupon two daughter-nuclei are formed.

**71. Kreuzungsuntersuchungen an Reispflanzen. III. Genetik der Farbeigenschaften verschiedener Pflanzenteile, des Wuchshabitus und der Ausschusszeiten. (Zugleich ein Beitrag zur Kenntnis der Koppelungsgruppe beim Reis).** Yasuke YAMAGUTI. (Ber. d. Ôhara Inst. f. Landw. Forsch., 5, 1931, 1-56).

Durch die Kreuzung der Zwergreispflanze, die an den ganzen Pflanzenteilen dunkelpurpurn gefärbt und grannenlos ist, mit der gewöhnlichen, die grün gefärbt und begrannt ist, wird es festgestellt, dass die Farbstoffbildung an den Blättern durch die Zusammenwirkung von drei Genen:  $P_1$ ,  $S$  und  $B$  bedingt wird. Das eigentliche Gen für die Blattfarbe,  $P_1$ , bleibt ohne Mitwirkung von  $S$  und  $B$  wirkungslos. Bei Anwesenheit von  $S$  färben sich die Spitzen der Spelzen rötlich.  $B$  modifiziert die rötliche Farbe der ganzen Pflanzenteile zu schwarzviolett oder dunkelpurpurn. Durch  $S$  und  $B$  wird auch die Narbenfarbe bedingt. Das angebliche Gen  $P_s$  für die Narbenfarbe kann in Wirklichkeit mit  $S$  identisch sein. Überdies wurde es festgestellt, dass für die Farbe der Spelzenspitzen noch ein Gen  $S_o$  beteiligt ist.  $S_o$  modifiziert die durch  $S$  bedingte rötliche Farbe der Spelzenspitzen zu orangerot. Die Wirkung des  $S_o$  auf  $S$  tritt aber bei gleichzeitigem Vorhandensein von  $B$  gar nicht oder wenigstens nicht stark auf. Der Wuchshabitus wird durch das Gen  $D$  bzw.  $d$  bedingt. Die Zwergform ( $dd$ ) verhält sich einfach rezessiv für langen oder normalen Form.  $D$  bzw.  $d$  wirkt ausser auf das Wachstum der ganzen Pflanzen ebenso auf das der einzelnen Pflanzenteile in gleichem Sinne. Für die Ausschusszeiten der in dieser Kreuzung benutzten Sorten sind die Gene  $F_2$  und  $F_3$  beteiligt. Das Gen  $F_2$  veranlasst bei einfacher Dosis 6-7 Tage, bei doppelter Dosis 12-14 Tage früher als  $f_2f_2$

Kombination, die Rispe auszuschliessen, während das Ausschiessen bei entsprechender Dosis von  $F_2$  2 bzw. 4 Tage früher stattfindet. Beide leiden in ihrer Wirkung von den Jahresschwankungen bzw. von der Veränderungen der Kulturbedingungen. Doch findet sich zwischen den individuellen Ausschusszeiten der in Süd-japan kultivierten  $F_2$ -Pflanzen und den durchschnittlich aus den in Nord-japan kultivierten  $F_3$ -Nachkommen der betreffenden Pflanzen berechneten eine starke Korrelation.  $r$  beträgt  $+0,823 \pm 0,038$ . Die Gene  $S, B, P_1, D$  und  $F_2$  spalten sich ganz unabhängig von einander.  $F_3$  steht mit  $S$  in einer Koppelung mit einem Austauschwert von 30,7%, und ebenso mit  $M$  in einer sehr lockerer Koppelung;  $F_3$  gehört zur  $S$ - $M$ -Koppelungsgruppe. Zwischen den  $S$ - $P_3, B$ - $P_3, B$ - $F_3$  und  $P_1$ - $F_3$  scheint äusserlich je eine Koppelung statt zu haben. Sie kann aber in jedem Falle noch nie sichergestellt angesehen werden.

Autor.

**72. Observationes ad floram formosanam I.** Yoshimatsu YAMAMOTO. (Jour. Soc. Trop. Agric. **3**, 1931, 236-245, 2 figs.).

The following new species are described: *Polypodium transpiananense*, *Selaginella tarokoensis*, *Calanthe seikoensis*, *Eria Sawadae*, *Utricularia taikankoensis*.

**73. On the growth of seedlings of wheat varieties distinguished by their power of cold resistance.** (Japanese with English résumé). Morimasa YAMASAKI. (Proc. Crop Sc. Soc. Japan **3**, 1931, 309-318).

When the seedlings of winter hardy varieties of wheat are cultivated under warm condition, they grow much rapidly than non-hardy ones, while when their cultivation takes place under cold winter condition, just the contrary is the case. It is well known that the power of cold resistance is proportional to the quantity of soluble carbohydrates (such as sugars) contained therein. If hardy varieties of wheat are cultivated under cold condition, their growth is slow as above stated, consequently the use of the photosynthetic products is correspondingly sparse which will lead to their comparatively large accumulation and stronger power of cold resistance.

**74. Physiological researches on the fertility in *Petunia violacea* IX. Some new experiments on the nature of the special substances which inhibit self-fertilization existing in the pistil.** (Japanese with English résumé). Sadao YASUDA. (Bot. Mag. Tôkyô **45**, 1931, 301-313).

To 20% watery solution of cane-sugar was added the juice got from fresh styles of *Petunia violacea*, or a little amount of dry powder of styles, or the dry matter of styles. The growth of pollen-tubes in such media was studied. It was observed that when the styles belonged to the strain different from that from which pollen was taken, this growth is much accelerated, while in the contrary case it is much inhibited. The fact that the inhibiting substance is present not only in the styles, but also in the ovaries, was experimentally proven.

For the experiment to graft the style upon the ovary here described cf. Japan. Jour. Bot. **5**, (117), No. 332.

**75. Cytological studies in artificially raised interspecific hybrids in *Papaver*. III. Unusual cases of cytokinesis in pollen mother-cells in a  $F_1$  plant.** Kono YASUI. (Cytologia 2, 1931, 402-419, 1 pl. and 28 text-figs.).

The first meiosis in the pollen mother-cell of the  $F_1$  plant *Papaver somniferum* × *P. orientale* is either normal or abnormal; in the latter case the first division, instead of producing two daughter-cells, gives rise to a reconstruction nucleus or to two daughter-nuclei connected by a bridge. After the first division is over, various modes of cytokinesis of pollen mother-cells occur in one and the same anther. Usually the phragmoplast gradually disappears at telophase, and consequently at the beginning of the second division no fibrillar structure is visible in the equatorial region of the first spindle. In other case, however, the phragmoplast becomes denser, and then gradually disappears: a secretion of small granules—middle lamella initial—appears, growing laterally and centrifugally across the equator; these granules which show the reaction of callose grew thicker, and fuse together to form a thin plate, the middle lamella. Still in another case, the formation of the middle lamella initial and the cleavage furrow (the latter, either from one or both sides of the equator of the mother-cell) occurs, and the callose membrane of the P.M. protrudes between the cleavages. The second division which produces the pollen tetrad is either simultaneous (tetrahedral pollen-grains) or successive (quadrate or decussate tetrad). Dyad and triad formations were also observed in one and the same anther.

**76. Botanische Studien subalpiner Moore auf vulkanischer Asche.** Y. YOSHII und N. HAYASI (Sc. Tôhoku Imp. Univ. Ser. 6, p. 1931, 307-346).

Der Kegelberg Ôdake mit einer Kratereinsenkung am Gipfel erreicht eine Höhe von 1580 m ü. M. und steht in der Mitte des Hakkôda-Massivs. Die Vulkane zeigen jetzt keine lebhaftete Tätigkeit, sind jedoch im Solfatatzustande. Auf einem westlichen Abhang des Bergs Ôdake kann man zwei ausgedehnte flache Terrassen sehen, auf denen sich Grasmoore entwickeln, die sich dadurch auszeichnen, dass eine grosse Anzahl kleiner Teiche mit aufgewölbten Rand hier und da auf ihnen zerstreut ist. Das Profilbild des Moorbodens bestätigt, dass sich die Moore auf vulkanischer Asche entwickelt haben. Die ausgeworfene, vulkanische Asche wurde auf den Terrassen abgelagert und später so hart zusammengepresst, dass sie kaum Wasser durchlässt. Durch Stagnierung des Sickerwassers in der Senke auf dem Aschenboden, begünstigt durch kaltes Bergklima, setzte Torfbildung ein. Man kann die Moore daher genetisch in die Kategorie der Quellmoore einreihen. Unter Quellmoor versteht man aber gewöhnlich solche, die auf nährstoffreichem, besonders kalkreichem Gelände entstehen und folglich mit eutrophen Pflanzen bewachsen sind. In unserem Falle ist es aber ganz anders; die Moore sind auf saurem, nährstoffarmem Aschenboden aus oligotrophen Pflanzen entstanden, wie das bei Hochmooren vorkommt. Sie sind daher nach KOPPE in die Reihe der primären oligotrophen Moore zu stellen.

Die kleinen Teiche, die durch einen ausgeprägt aufgewölbten Rand ausgezeichnet sind, werden in folgender Weise gebildet: An den Stellen, wo horizontaler oder schwach geneigter Moorboden plötzlich eine Neigung verändert, tritt Quellwasser aus. Infolgedessen tritt dort üppige Vegetation auf und schreitet die Torfbildung fort,

wodurch Ablagerung des Torfs um den Quellpunkt herum zunimmt. Mit dem Emporsteigen des Randes füllt das Quellwasser den Teich aus, und je höher das Wasserniveau steigt, desto höher wölbt sich der untere Rand, wobei seine Unterlage stets von Teichwasser durchnässt ist und ihn zu weiterem Wachstum der Pflanzen veranlasst.

Die mit der Standortsaufnahme-Methode erzielten Ergebnisse zeigen, dass die beiden Seiten eines Teiches verschiedene Vegetationseinheiten liefern. Besonders abweichende Verschiedenheit lassen die Teiche erkennen, die einen aufgewölbten Rand besitzen. Während auf der oberen Seite wenige Arten vorkommen, siedeln sich auf der unteren viele an. Das ist in den verschiedenen ökologischen Bedingungen, besonders in der abweichenden Wasserversorgung an jeder Stelle, entsprechend dem Emporsteigen des Randes, begründet. Die Pflanzen an den Teichen lassen sich nach dem Stetigkeitsgrad folgendermassen ordnen: *Molinia japonica* (*Moliniopsis japonica* HAYATA), *Eriophorum gracile*, *Geum pentapetalum*, *Drosera rotundifolia*, *Narthecium asiaticum*. Die ersten drei sind stete Arten. In den meisten Teichen wächst üppig *Menyanthes trifoliata*.

YOSHII



## Abstracts Nos. 77—213

(Referring to the principal papers on Botany and allied subjects which have appeared in Japan chiefly during January–June 1932).

**77. On the effect of sunlight on the infection of the rice plant by *Piricularia Oryzae*.** (Japanisch). TAKUJI ABE. (Forsch. aus d. Geb. d. Pflanzenkh. **1**, 1931, 46–53).

Die Reissämlinge, die mit dem die Sporen von *Piricularia Oryzae* enthaltenden Wasser begossen wurden, wurden während 8–12 Stunden in den hellen bzw. dunklen Kästen gelegt, und zwar unter sonst ganz gleichen Bedingungen. Es wurde dabei gefunden, dass die kranken Flecke immer viel zahlreicher vertreten sind in den dunkelgehaltenen Sämlingen als in den anderen. Das Licht verhindert somit die Infektion zum gewissen Grade.

**78. On the effect of copper sulphate upon the susceptibility of the rice plant to the blast disease.** (Japanese). TAKUJI ABE and EIJI OKAMURA. (Forsch. aus d. Geb. d. Pflanzenkrankh. **1**, 1931, 54–70).

Either in water or soil culture of rice plant, young or adult, copper sulphate was given for studying its influence upon the susceptibility to blast disease. It was found that the susceptibility is inversely proportional to the quantity of copper sulphate given. Thus, for instance, in young plants, if we take the number of disease spots per 100 mm leaf length for unit it is 1,793, 2,262, 2,925 according as the concentration of copper sulphate is  $\frac{1}{500\ 000}$ ,  $\frac{1}{1\ 000\ 000}$  or 0 respectively. The same was observed in adult plants. It is to be noted that the growth of rice plants is inversely proportional to the quantity of copper sulphate taken into use.

**79. Karyologische Untersuchungen über einen Artbastard zwischen *Potentilla chinensis* (haploid 1n) und *P. nipponica* (haploid 2n).** Seiichi ARAKI. (Jour. Sc. Hiroshima Univ. Ser. B, Div. 2, **1**, 1932, 103–116, 2 Taf. u. 17 Textabb.).

Der Verf. hat einen Artbastard zwischen *Potentilla chinensis* (haploid  $7=1n$ ) und *P. nipponica* (haploid  $14=2n$ ) bekommen im Gegensatz zu MÜNTZING, der bei der Bastardierung von *Potentilla* bloss pseudogamische mütterliche Nachkommen erhalten hatte. Der vom Verf. bekommene Artbastard ähnelt äusserlich mehr dem höhergenomigen Elter als dem mindergenomigen. Bei heterotypischer Metaphase in den P.M.Z. dieses Bastards konnte der Verf. ausser den uni- und bivalenten auch tri- oder sogar quadrivalente Chromosomen beobachten.

**80. Untersuchungen über die Bedeutung des Mannits im Stoffwechsel einiger höheren Pflanzen. Teil I.** Toichi ASAI. (Japan. Jour. Bot. **6**, 1932, 63–101, 10 Textabb.).

**81. Eine neue Art von Myxomyceten.** (Mit japan. Zfg.). Yoshikadzu EMOTO. (Bot. Mag. Tôkyô **46**, 1932, 170-171, 1 Taf.; 359).

Eine neue Art Myxomyceten, *Enteridium Yabeianum* wird beschrieben und abgebildet.

**82. On *Cercospora circumscissa* SACC., pathogenic on the leaves of *Prunus Mume* S. et Z.** Shigeru ENDO. (Trans. Tottori Soc. Agric. Sc. **2**, 1931, 249-252).

In the culture of *Cercospora circumscissa* parasitic on leaves of *Prunus Mume* the chlamydospores are very easily developed, while the conidial formation takes place with difficulty. The optimum temperature for fungal growth is 24-28°C.

**83. Studies on the sclerotium disease of the rice plant. IV. On the morphology of certain important fungi causing sclerotium diseases of the rice plant.** Shigeru ENDO. (Forsch. aus d. Geb. d. Pflanzenkrankh. **1**, 1931, 126-148, 1 pl.).

An enumeration of 7 kinds of fungi causing sclerotium disease of rice plants in Japan with morphological description. They are *Hypochnus Sasakii*, *Sclerotium Oryzae sativae*, Sc. sp. (3 species), *Entostroma Oryzae* (= *Sclerotium phyllachoroides*), and *Hypochnus centrifugus*.

**84. Studies on the sclerotium diseases of the rice plant V. Ability of overwintering of certain important fungi causing sclerotium disease of the rice plant and their resistance to dry conditions.** (With English résumé). Shigeru ENDO. (Forsch. a. d. Geb. d. Pflanzenkrankh. **1**, 1931, 149-167).

Many fungi causing the sclerotium diseases are able to overwinter in soil, either as sclerotia or mycelia. The sclerotia of some fungi placed in a dessicator during 21 months were found to keep their viability, while some others kept in dry soil for nine months showed vigorous viability.

**85. Über die Beziehungen zwischen dem Eiweissgehalt der Blätter und dem Grad der Sonnenbeleuchtung.** (Japanisch m. deutsch. Zfg.). Teru FUJITA. (Bult. Sc. Fak. Terk. Kjušu Imp. Univ. **4**, 1931, 358-368).

Der Verf. hat den Eiweissgehalt der Blätter unter drei durch die Bedeckung mittels Tuchkästen ermöglichten verschiedenen Stufen der Sonnenbeleuchtung bestimmt und fand, dass je geringer der Beleuchtungsgrad war, umso geringer der Eiweissgehalt war. Dabei hat die Anwendung der KÔKETSUSCHEN Pulvermethode die vorzüglichsten Resultate gegeben.

**86. Untersuchungen über die Bestockung der Reispflanzen (*Oryza sativa*) II. Einfluss der Wasser- und Lufttemperatur und der Luftfeuchtigkeit auf die Bestockung.** (Japanisch m. deutsch. Zfg.). Sadayoshi FUKAKI. (Bult. Sc. Fak. Terk. Kjušu Imp. Univ. **4**, 1931, 236-357).

Die Experimente wurden unter künstlich durch elektrische Einrichtung resp. die Anwendung des Austrocknungsmittels ermöglichten verschiedenen Temperatur- und Feuchtigkeitsbedingungen ausgeführt. Es ergab sich dabei, dass 1. die erste Entfal-

tung des Bestockungstriebs am frühesten stattfindet unter solch einem Temperaturgrade, dass das nach dem Trockengewicht beurteilte maximale Wachstum der oberirdischen Teile erzielt wird, und 2. dass die Temperatur für die maximale Gesamtlänge der Bestockungshalme mit derjenigen des maximalen Trockengewichtes der oberirdischen Teile übereinstimmt. Weiter wurde es nachgewiesen, dass der Bestockungsgrad sowie auch das Trockengewicht des oberirdischen Teiles mehr begünstigt wird in feuchter Luft als in trockener.

**87. On the effect of plant nutrients and sunlight on the formation of first "anlage" of the tillers in rice plant.** (Japanese). Sadayoshi FUKAKI. (Proc. Crop Sc. Soc. Japan **4**, 1932, 115-117).

It is well known that the growth of the tillers of the rice plant which have already pushed away from the leaf-sheath is largely influenced by external agents, such as light, nutriment, etc. But the question, what relation will exist between the production of the first "anlage" of the tillers and external agents is not yet studied. The experiments of the author towards this problem have given the following results. The reserve substance existing in each plant itself is quite sufficient for the production of the first "anlage" of the tillers, and it was observed that corresponding to the decrease of this substance during its growth the latter process becomes retarded gradually. The production of the "anlage" under question seems to be quite independent of sunlight.

**88. On the genetico-physiological studies of the colour-development of flowers in *Pharbitis Nil*.** Tokio HAGIWARA. (Proc. Imp. Acad. **8**, 1932, 54-57).

By means of various crossing experiments the author has attained to the conclusion that for the production of coloured flowers in *Pharbitis Nil* four complementary genes *C<sub>a</sub>*, *C*, *R*, and *A* are necessary. The flower colour may be either pure or broken, and the author gives as the results of various crossing experiments the genetical formulae of various kinds of flower colour belonging to either category. All these flower colours are due to anthocyanin. KATAOKA has formerly discovered two kinds of anthocyanins, viz. pelargonin from red flowers and paeonidin from purple ones. According to the hypothesis of WILLSTÄTTER there must be two kinds of flavones accompanying these two anthocyanins, and the author's studies have given the results leading to the conclusion that there are in fact two kinds of flavones corresponding to these anthocyanins.

**89. Über die sukzessiven Holzbastringe von *Pueraria triloba*, MAKINO und *Wistaria floribunda*, DC.** (Japanisch m. deutsch Zfg.). Tugio HANDA. (Bot. Mag. Tôkyô **46**, 1932, 13-22, 7 Textabb.).

Sowohl im Stamme als in der Wurzel von *Pueraria triloba* entsteht im Perizykel die Mutterschicht der Folgeremisteme, die durch die Erzeugung von sukzessiven Holzbastzonen das wohlbekannte abnorme Dickenwachstum herbeiführen. Die in ein und demselben Ringe gehörigen Holzbastzonen bilden sich nicht immer früherer nahe der Grenze zwischen dem Stamm und der Wurzel als andererorts. Weiter wurde es



nachgewiesen, dass an den Teilen, wo der Stamm sich dicht um den Stützbaum windet, die Neigung überflüssige Holzbastzonen auszubilden vorhanden ist. In der Wurzel stehen die zu den verschiedenen Ringen gehörigen Holzbastzonen durch Fibrovasalstränge in Verbindung, und dabei verursachen die letzteren die Bildung kleiner Lücke an denselben.

Das Verhältnis bei *Wistaria floribunda* ist ganz dem vorigen ähnlich.

**90. Delay of the heading time in rice by cutting. A preliminary note.** (Japanese). Siroku HARA. (Ann. Agric. Exp. Sta. Gov.-Gen. Chosen (Tyôsen) **6**, 1932, 48-55).

When the stock of paddy rice plant is cut off at a distance of about 15 cm. above ground (or water-surface) a new shoot will spring up soon after. If the time of cutting is variously changed, the heading time of the new shoot will also change correspondingly. Such shoot will be used conveniently for crossing various strains whose heading time differs more or less widely from it under natural condition.

**91. Relation entre l'âge des graines et le sexe chez l'épinard.** (En japonais). Sirô HAYASI. (Agric. & Hort. **7**, 1932, 1449-1456, 3 figs.).

La proportion numérique des plantes mâles et femelles chez l'épinard (*Spinacia oleracea*) donnée par divers auteurs jusqu'à aujourd'hui n'est pas toujours la même, par exemple, 1:1 (NOHARA), 52,5% ♂ : 38,8% ♀ : 8,7% ♀ (ROSA), etc.

L'auteur a étudié ce problème en employant des graines âgées différemment. Il a observé que celles âgées de 1-3 ans donnent des plantes de deux sexes en proportion presque égale, mais que chez celles âgées plus de 4 ans elle est tout à fait différente de l'égalité, par exemple, 70,9, 73,5, ou 75 ♂ contre 100 ♀. Le nombre des plantes monoïques issues en même temps est si petit qu'il ne changera pas la proportion numérique des plantes mâles et femelles essentiellement, par exemple seulement 2-3 contre 100 ♀.

La prépondérance femelle chez les plantes issues des vieilles graines indiquée ci-dessus est facile à comprendre, u le fait observé par l'auteur, que le pourcentage de la germination est considérablement plus bas chez les vieilles graines que chez les jeunes. Ce fait est dû évidemment à la mort d'un certain nombre des graines au cours du temps, d'où l'on peut voir que les plantes femelles sont prépondérantes alors, parce que les graines mâles étant plus faibles que les femelles sont beaucoup plus destinées à la mort que celles-ci.

**92. Notes on some Japanese fungi.** (With Japanese résumé). Takewo HEMMI (Bot. Mag. Tôkyô **46**, 1932, 160-167, 5 text-figs.; 358).

Concerning the following fungi the description is given or some notice is made with figures, viz. *Clavaria Miyabeana*, *C. amethystinoides*, *C. acuta*, *C. Kunzei*, *Pleurotus porrigens*, *Femsjonia luteo-alba*.

**93. Studies on some wood-destroying fungi attacking conifers in Japan.** Takewo HEMMI. (Mem. Coll. Agric. Kyoto Imp. Univ. No. **20**. 1932, 29 pp., 5 pls.).



The fungi attacking conifers in Japan are among others *Fomes ulmarius*, *F. Laricis*, *F. pinicola*, *Polyporus orientalis*, *P. Schweinitzii*, *P. sulphureum*, *Trametes Pini*, all of which are very destructive. The mode of decay of the important conifers in Japan may be classified into brown cubical rot, brown pocket rot and white pocket-rot. The mode of decay of each fungus above mentioned as well as the host trees for each are noticed in a table.

**94. On the relation of temperature and period of constant wetting to the infection of the rice plants by *Piricularia Oryzae*.** (Japanese with English résumé). Takeo HEMMI and Takuji ABE. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1932, 33-45).

The authors have put the rice seedlings sprayed with the spore suspension of *Piricularia Oryzae* in a moist chamber under various temperatures 20-34°C, and studied what will be the minimum time of continuous wetting under these temperatures for successful infection. They found, for instance, : 32°—about 10 hours, 28°—about 8 hours, 24°—about 6 hours, 20°—about 6-8 hours.

Similar experiments were done also with leaves of adult plants.

**95. Studies on sclerotium diseases of the rice plants III. Some experiments on the sclerotial formation and the pathogenicity of certain fungi causing sclerotium diseases of the rice plant.** (Japanese with English résumé). Takewo HEMMI and Shigeru ENDO. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 111-125).

For instance, the sclerotia of *Hypochnus Sasakii* are formed more abundantly under light than in dark. Their formation is accelerated by sudden fall of temperature.

**96. Pathological studies on *Polyporus betulinus* (BULL.) FR.** (Japanese with English résumé). Takewo HEMMI and Shizuko KURATA. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 206-224, 2 pls. and 3 text-figs.).

*Polyporus betulinus* causes the decay of wood of birches, and belongs to the class of the cellulose dissolving fungi. The pure culture is easily to be done: the apricot decoction and the dilute Japanese soy with onion decoction seem to be the best culture media. The fungus grows between 5-36°C, and best at 28°C.

**97. Notes on three diseases of Azaleas.** (With Japanese résumé). Takewo HEMMI and Shizuko KURATA. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 1-12, 2 pls.).

Two kinds of leaf-spot diseases are described, the one due to *Venturia Rhododendri*, and the other to *Cercospora Handelii*. The black-spot disease known to be caused by *Melasmia Rhododendri* is much prevalent near Kyôto, and the authors have got perfectly ripe ascospores. Basing on the morphology of the ascus generation the authors came to call this fungus by a new name *Rhytisma Shiranana*.

**98. Beiträge zur Kenntnis der japanischen Pilze. I.** (Japanisch). Takewo HEMMI und Shizuko KURATA. (Fungi **1**, 1931, 83-98, 3 Textabb.).

Die folgenden Pilze sind beschrieben: *Cercospora Pancratii*, *Gloeosporium Crini*, *G. Olivarum*, *Myxosporium juglandinum*, *Protomyces Lactucæ-debilis*, *P. Inouyei*, *Belonioscypha ciliatosporea* und *Geoglossum nigratum*.

**99. Über *Polyporus Mikadoi*** LLOYD. (Japanisch). Takewo HEMMI und Tomowo NOJIMA. (Fungi **1**, 1931, 90-95, 4 figs.).

The form and the decaying action of *Polyporus Mikadoi* are described.

**100. On the relation of temperature and period of constant wetting to the infection of the rice blast by *Ophiobolus Miyabeanus*.** (Japanese with English résumé). Takewo HEMMI and Tomowo NOJIMA. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 84-89.).

The minimum time of constant wetting under the temperature 20-24°C for successful infection of the rice plant by *Ophiobolus Miyabeanus* was studied. It is: 20°—about 8 hours, 25° and 30°—about 4 hours, 35°—about 6 hours.

**101. Studies on the "bakanae"-disease of the rice plants III. On the infection of rice by *Lisea Fujikuroi* SAWADA and *Gibberella Saubinetii* (MONT.) SACC. in the flowering period.** (Japanese with English résumé). Takewo HEMMI, Fusataro SETO and Jūkichi IKEYA. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 99-110).

The authors' experiments have proven that both *Lisea Fujikuroi* and *Gibberella Saubinetii*, the causal fungi of the bakanae disease, are able to infect the rice seeds in the flowering period. Such seeds which are externally indistinguishable from the normal ones will pass winter, and contribute to the dissemination of the disease.

**102. On the relation of soil moisture to the development of the *Helminthosporium* disease of rice seedlings.** (Japanese with English résumé). Takewo HEMMI and Hashio SUZUKI. (Forsch. a. d. Geb. d. Pflanzenkrankh. **1**, 1931, 90-98).

The authors' experiments have shown that the rice seedlings grown on dry soil are more susceptible to the infection by *Helminthosporium Oryzae* and *Ophiobolus Miyabeanus* than those grown in humid soil.

**103. On the daily progress of carbon assimilation in the shadow under natural conditions.** Keinosuke HIRAMATSU. (Sc. Rpts. Tôhoku Imp. Univ. 4. Ser. **7**, 1932, 239-257, 7 text-figs.).

The experiments were performed in Mt. Hakkôda on shade and sun plants, each containing four species. The apparatus of BOYSEN-JENSEN was used, and the duration of experiment was 25-30 minutes.

The results are as follows. The assimilating power of shade plants is usually weaker than that of sun plants. The process is always stronger in the morning than in the afternoon. In the shade plants strong assimilation was observed in late afternoon, but not always in shade leaves of sun plants. In noon time the remarkable depression of assimilation usually takes place, except in rainy days. The curve of assimilation does not go always parallel either with that of light or of temperature, though it does on fine, rainy and cloudy days.

**104. Inoculation experiments with some heteroecious species of the Melampsoraceae in Japan.** Naohide HIRATSUKA. (Japan. Jour. Bot. **6**, 1932, 1-33).

**105. On the influence of osmotic pressure of culture media on the mycelial growth of *Piricularia Oryzae* B. et C.** (Japanese with English résumé). Shigekatsu HIRAYAMA. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 27-32, 2 figs.).

To the potato decoction agar were added different quantities of glucose or glycerin to make solutions of different osmotic pressure. It was observed that the mycelial growth was more vigorous in the media of higher osmotic pressure.

**106. On the effect of soil moisture to the cell sap concentration of rice seedlings.** (Japanese with English résumé). Shigekatsu HIRAYAMA. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 21-26).

It was formerly observed by HEMMI that there is a certain relation between the moisture and the development of the rice blast disease caused by *Piricularia Oryzae*, inasmuch as a decrease of soil humidity causes an increase in the destruction of the disease. Now the experiments of the author have shown that the cell-sap of the seedlings grown in the arid soil was always more concentrated than those grown in humid soil. It is probable that the cell sap concentration has a certain relation, either direct or indirect, to the susceptibility of the rice plant to blast disease.

**107. Nuntia ad floram japoniae XV-XVI.** (With Japanese résumé). Masaji HONDA. (Bot. Mag. Tôkyô **46**, 1932, 1-3, 23-24, 371-374, 391-392).

The following new species are described: *Melica kumana*, *Calamagrostis insularis*, *Saussurea pseudo-sagitta*, *Anaphalis todaiensis*, *Leontopodium perniveum*. A new genus *Senisetum* belonging to the Poaceae is created, which contains *S. Hideoi* (OHW.) HONDA comb. nov.

**108. On a new species of *Didymoplexis*.** (With Japanese résumé). Masaji HONDA. (Bot. Mag. Tôkyô **46**, 1932, 168-169, 359).

A description of *Didymoplexis nipponica* sp. nov.

**109. Die epiphyllen Lebermoose von Japan.** (M. japan. Zfg.). Yoshiwo HORIKAWA. (Bot. Mag. Tôkyô **46**, 1932, 176-187, 1 Taf.).

27 Arten von epiphyllen Lebermoosarten sind hervorgehoben, unter denen *Leptocolea liukiensis*, *L. miyajimensis*, *Physocolea papillosa* und *P. shikokiana* neu und beschrieben sind.

**110. Studies on the Hepaticae of Japan. VI-VII.** Yoshiwo HORIKAWA. (Jour. Sc. Hiroshima Imp. Univ. Ser. B, Div. 2, **1**, 77-94, 2 pls. and 17 text-figs.; 121-134, 3 pls. and 9 text-figs.).

The following new species are described with illustrations. *Alicularia biloba*, *Plagiochila robustissima*, *P. minima*, *Saccogyna curiosissima*, *Bazzania montana*, *Scapania densiloba*, *S. plagiochiloides*, *Archilejeunea japonica*, *Drepanolejeunea*



*foliicola*, *Leptocolea ocellata*, *L. pseudofloccosa*, *L. microlejeuneoides*, *L. ciliatilobula*, *L. magnistyla*, *Aphonolejeunea angustiloba*, *A. magnilobula*, *Haplozia submersa*, *Cephalozia montana*, *Scapania robusta*, *Radula magnilobula*, *Lopholejeunea apiculata*, *L. kiushiana*. Besides *Scapania spinosa* STEPHANI and *Pycnolejeunea pilifera* STEPHANI are described in detail.

**111. Supplement to "Studies on leaf-fall disease of *Diospyros Kaki*." I.** (Japanese). Suehiko IKATA. (Rpt. Okayamaken Agric. Expt. Sta. **37**, 1932, 19 pp., 5 pls.).

*Cercospora Kaki*, the causal fungus of angular leaf-fall disease of *Diospyros Kaki* (s. Japan. Jour Bot. **5**, (6), No. 19) was studied concerning the mycology as well as the methods of control.

The artificial inoculation with conidia as well as mycelia was done with success, and it was observed that they remain latent during 29-30 days after inoculation in the former case, and 29-31 in the latter. The growing tube creeps over the surface of leaf, and the primary tube, though it passes over the stomata, never penetrates into them. Only its short branches (either secondary or tertiary) were seen to go through them. No cuticular penetration was observed. The infection tube produced by such branches penetrates into the respiratory cavity, and produces some vesicular nodes, from which a number of infection hyphae will come out.

**112. Studies on "Kurobosi" (black star)-disease of *Diospyros Kaki*.** (Japanese). Suehiko IKATA (Rpt. Okayamaken Agric. Exp. Sta. **37**, 1932, 48 pp., 7 pls.).

The disease which is seen both on young and adult plants, leads to the fall of leaves and fruits, causing a great damage to the cultivators. The causal fungus is *Fusicladium Levieri* MAGN.; though it was once named *F. Diospyrae* HORI et YOSHINO, it is hardly distinguishable from *F. Levieri*. On various nutrient media it produces conidia, especially on standard agar medium. Infected artificially on leaves, the conidia remain latent during 7-10 days, and then begin to germinate. Under natural condition the mycelium passes the winter in the lesional parts of the branch, and in April produces basidia. The infection takes place through the cuticle: the fungus penetrates through the contact lines of two neighbouring epidermal cells, dissolves the middle lamella, and goes into the intercellular space below the epidermis. It produces then a vesicle, from which the hyphae go out. The latter do not enter the cells, pass simply through the intercellular space, and yet finally lead to the death of host cells.

**113. On the mode of penetration of a *Peronospora* species into a host.** (Japanese). Suehiko IKATA and al. (Jour. Plant Prot. **17**, 1930, 6 pp., 5 figs.).

The study was done on *Peronospora Brassicae* parasitic on *Brassica pekinensis*. In the case of drop culture the conidia of this fungus produces a germinating tube which in contact with the surface of the object-glass produces in its turn a vesicle at its apex and other parts. The latter which measures  $13-25.6 \times 10-16$  is considered to be the appressorium. When the infection of conidia is made on leaf surface, each of them produces a germinating tube, from which a vesicle is developed on a stoma. A



long hypha coming out from it penetrates into the host tissue through the stomata. No cuticular infection was seen. The cytological study done by the authors has confirmed what was noted above.

**114. A new blight disease of the grape vine.** (Japanese with English résumé). Suehiko IKATA and Tsuyoshi HITOMI. (Ann. Phytopath. Soc. Japan **2**, 1931, 357-373, 2 pls.).

The disease much resembles that caused by *Isariopsis clavispora*, but it is due to *AcrospERMUM viticola* IKATA n. sp., and easily distinguishable by the concentric spots, giving the disease a "target-board" effect. The author has performed the culture of the causal organism which produces the conidia, but not the perithecia. Inoculation with either conidia or ascospores was made on some American vine species. It is successful, when they are inoculated on the lower surface of leaves, the penetration of the fungus being brought about through the stomata. The perithecia begin to be formed in November, and the ascospores are completed in June-July. The optimum temperature for its growth is 20-25°C.

A description of the fungus is given.

**115. A preliminary report of a new septorial leaf-spot disease of the lily leaves.** (Japanese with English résumé). Sanae IKENO. (Agric. and Hort. **7**, 1932, 1421-1439, 2 pls.).

The disease of the leaves of *Lilium auratum* which is characterized by the appearance of brown lesions commonly elongated is due to a new fungus called *Septoria lilii*. The mycelium is branched and septate, and pycnidia are developed. In the nutrient media the mycelial cells of one type swell up and change into chlamydospores. Conidia are developed on them, but not pycnidia. The growth takes place between 0-32°C, and the optimum lies between 20-24°C. Conidia die by being dipped into hot water 53°C for 10 min. and 55°C for 5 min.

**116. Contribution to the knowledge of the classification of Helvellaceae.** (With Japanese résumé). Sanshi IMAI. (Bot. Mag. Tôkyô **46**, 1932, 172-175, 359-361).

An enumeration of 18 species of Helvellaceae belonging to the genera *Helvella*, *Verpa*, *Helvelleta*, *Neogyromitia* and *Morchella*. The following are new: *Helvella ephippioides*, *H. discinoides* and *Morchella Miyabeana*.

**117. Embryological studies on *Sargassum* and *Cystophyllum*.** Shunpei INOH. (Jour. Fac. Sc., Hokkaido Imp. Univ. Ser. V, **1**, 1932, 125-133, 7 text-figs.).

In the liberaten eggs of *Sargassum* and *Cystophyllum* both the first and the second segmentation-wall run transversely, and by the second one a small rhizoid cell is formed at the lower extremity of the embryo. In *Sargassum nigrifolium*, *micracanthus* and *tosaense* the rhizoid cell is divided into sixteen cells, from which a group of sixteen rhizoids is developed (sixteen-cells type). In *Cystophyllum hakodatense* the rhizoid cell is divided into four cells, each of the latter developing into one rhizoid (four-cells type). That *Cystophyllum Turneri* belongs to the 32-cells type has been formerly observed.

**118. On two new species of Corallineae from the Tertiary of Japan.** Wataru ISHIJIMA. (Japan. Jour. Geol. and Geogr. **9**, 1932, 134-147, 2 pls.).

*Jania Lemoinei* and *Corallina elliptica* are described.

**119. On the rot-disease of the seeds and seedlings of rice-plant caused by some aquatic fungi.** Seiya ITO and Masaji NAGAI. (Jour. Fac. Agric. Hokkaido Imp. Univ. **32**, 1932, 45-69, 4 pls.).

The rot-disease of the seeds and seedlings of rice-plant which is characterized by the formation of white hyphae or a cottony mass, either at the collar of plumule or on the grain surface, is due to the action of four different kinds of the organisms, either independent or combined, viz. bacteria, hyphomycetous fungi, water moulds and *Pythium*-allies. Concerning them the authors have isolated a certain number, and examined the cultural characters as well as the temperature relation. Among them there are *Achlya americana*, *A. flagellare*, its var. *yessoensis*, *A. Oryzae*, *Dictyuchus sterile*, *Pythiomorpha Miyabeana* and *P. Oryzae* (the two latter being new species).

The mycelial growth and sporangial formation on various nutrient media and under various temperatures were studied. The artificial infection was also performed.

**120. On the influence of oryzanin upon the development of some parasitic fungi.** (With Japanese résumé). Seiya ITO and Mutsuo TERUI. (Bot. Mag. Tôkyô **46**, 1932, 223-224, 368-369).

The nutritive effect of oryzanin upon three fungi, viz. *Ophiobolus Miyabeanus*, *Gibberella Fujikuroi* and *Piricularia Oryzae* was studied. By the addition of a certain quantity of this kind of vitamin to the nutrient media the better development, the acceleration of conidial formation, as well as that of conidial germination were achieved. Though the conidial formation was accelerated when oryzanin was added as the only nitrogen source, the acceleration was no better than sugars, when it is the only carbon source. At the temperature 15-20°C the influence was found to be most prominent.

**121. Pollen-analytical studies of peat formed on volcanic ash.** Tadao JIMBO. (Sc. Rpts. Tôhoku Imp. Univ. 3. Ser. **7**, 1932, 129-132).

On Mt. Hakkôda in Northern Japan there is a grassy moor developed on volcanic ash. Under this moor lie several layers of peat intercalated by those of volcanic ash. In the upper peat layer the author has found a large number of *Abies* pollen which could be scarcely seen in the lower, while concerning the pollen of *Fagus* and *Quercus* just the contrary was the case. The author concludes therefore that *Fagus* and *Quercus* were predominating in older time, while *Abies* is predominating more recently. In fact a large area in the upper part of the mountain is covered at present by forests of *Abies Mariesii*.

**122. Eine botanische Untersuchung der *Microspira furfur* ROBIN.** T. KAMBA-YASHI. (Bot. Mag. Tôkyô **46**, 1932, 232-238, 3 Taf.).

Eine Kulturstudie von *Microspira furfur*, des Erregers der Pityriasis versicolor wurde vom Verf. ausgeführt. Als Nährboden wurde immer das SABOURAUDSche

Glukose-Pepton-Agar gebraucht. Die Kultur dieses Pilzes ist keineswegs leicht, und es gelang dem Verf. nur zwei Reinkulturen zu bekommen. Die erste Entwicklung ist als einige kleine gelblichweisse knotige Kolonien erkennbar. Dann entwickeln sich zahlreiche kleine Kolonien, welche allmählich dichtgedrängt werden und durch Vereinigung eine mässig grosse gelblichweisse Kulturmasse bilden. Die Sporen sind eiförmig oder länglichoval, woraus sehr kurze Hyphen sich entwickeln. Die ausgewachsenen Hyphen sind meistens in verschiedener Form gekrümmt. Einige relativ lange Hyphen verlaufen gerade und werden in mehrere Abteilungen geschnürt. Die Konidien bilden sich an den Konidienträgern oder häufig direkt an Hyphen. Keine Sterigmen sind nachweisbar. Oftmals sieht man die Sporenkette.

In RABENHORSTS Kryptogamenflora nennt LINDAU diesen Pilz *Sporotrichum furfur*, zu der Verf. nicht zu stimmen kann, wenn er von der Ansicht ist, dass wahrscheinlich sein Pilz systematisch *Sporotrichum* nahe verwandt sein mag.

### 123. Weitere Untersuchungen über die pentaploiden *Triticum*-Bastarde II.

Hitoshi KIHARA. (Japan Jour. Bot. **6**, 1932, 1932, 35-62, 2 Textabb.).

### 124. Genetische Studien an gestreiften Sippen von *Celosia cristata*. I.

(Japanisch. m. deutsch. Zfg.). Hitoshi KIHARA. (Agric. & Hortic. **7**, 1932, 1003-1026, 1 Farbentaf. u. 4 Textabb.).

Die rotgestreifte Sippe von *Celosia cristata* ist durch grüne Sprosse sowie gelbe rotgestreifte Blütenähren und Hahnenkämme charakterisiert. Diese Mosaikbildung wird durch die Wirkung eines mutables Gens  $a$  ermöglicht, das oft zu  $A$  (rot) mutiert, wenn die Mutationfrequenz nach den Sippen verschieden ist. Die roten Heterozygoten  $Aa$  spalten zu rot gestreift 3:1 auf  $A$  ist konstant.

Der Verf. konnte eine Reihe multipler Allelen feststellen, nämlich  $a$  für grüne Sprosse und gelbe Blüten, mutabel;  $a_k$  wie  $a$ , konstant,  $A_p$  für lachsrosa Grundfärbung und  $A$  für rote Färbung.

Eine lachsrosa rotgestreifte Pflanze zeigte sich die Aufspaltung zu lachsrosa (+ lachsrosa rotgestreift): grün rotgestreift = 3:1.

Die Heterozygoten  $aa_k$  sind rein grün oder etwas gestreift. Unter den  $F_2$  Nachkommen sieht man eine Aufspaltung zu gelben und gestreiften, welche von 3:1 weit abweicht (z.B. gelb: gestreift = 9010:58), was darauf hinweist dass bei der Verbindung  $aa_k$  die Mutabilität des Gens  $a$  stark herabgemindert wird, und nach der Verfs. Ansicht höchst wahrscheinlich durch die direkte Beeinflussung von seiten  $a_k$ .

### 125. Über die alpinen Pflanzen der Tôrohôkette in Nordkorea. (Japanisch m. deutsch. Zfg.). Yosh hiko KISHINAMI. (Bot. Mag., Tôkyô **46**, 1932, 293-301, 1 Taf.).

Der Verf. machte im Sommer 1931 eine Studienreise im Gebiete von Tôrohôkette in Nordkorea, mehr als 1000 m hoch über das Meeresniveau. 73 Arten, 19 Varietäten und 2 Formen Alpenpflanzen wurden gesammelt, welche in diesem Aufsatz hervorgehoben sind. In dem zugefügten Tafel sind 4 Alpenpflanzen (aus *Silene*, *Leontopodium*, *Ligularia* und *Luzula*) abgebildet.



**126. Compositae novae japoniae. II.** S. KITAMURA. (Acta Phytotax. et Geobot. **1**, 1932, 56-60.)

4 new species and 1 new variety are described: *Cirsium albescens*, *C. Hosokawai*, *C. japonica* var. *takaoense*, *C. Suzukii*, *Lactuca trifida*.

**127. Contributiones ad cognitionem florum Asiae orientalis.** Gen'iti KOIZUMI. (Acta Phytotax. et Geobot. **1**, 1932, 1-33.)

Two new genera, *Sinomalus* belonging to the Pomaceae and containing two species, and *Lunathyrium* (*Athyrium*) are established. The following are new species: *Sorbus diabolica*, *S. pachyphylla*, *Rubus sohayakiensis*, *R. ohmineanus*, *Tricyrtis chugokuensis*, *Epimedium setosum*, *Celtis Hashimotoi*, *Cynanchum Doianum*, *Diplazium kiusianum*, *Dryopteris nipponiensis*, *D. hondoensis*, *D. medioxima*, *D. Takeuchiana*, *Polypodium Sakaguchianum*, *Lunathyrium pycnosorum*, (n. g. et n. sp.) (= *Athyrium pycnosum* CHRIST), *Lycopodium quasiprimaevum*.

**128. Untersuchungen über "Photoperiodismus" der Reispflanzen. Erste Mitteilung.** Mantarô KONDÔ, Tamotsu OKAMURA, Shigeo ISSHIKI und Yasuo KASAHARA. (Ber. Ôhara Inst. f. landw. Forsch. **5**, 1932, 243-280 m. 9 Taf.; auch in japanisch in Nôgyô Kenkyû (Landw. Studien) **18**, 1932, 161-225 m. 10 Photographien).

Die jungen Reispflanzen wurden ausser der natürlichen Belichtung ausgesetzten Kontrolle wie folgt behandelt: 1.4 oder 8 Stunden belichtet (d.h. vom 8 Uhr Morgen bis zum Mittag bzw. 4 Uhr Abend), sonst im Dunkel gehalten, 2.12 Stunden belichtet (d.h. vom 8 Uhr Morgen bis zum 8 Uhr Abend durch Sonne oder elektrisch), sonst im Dunkeln gehalten; 3.24 Stunden belichtet (d.h. am Tage durch Sonne und an der Nacht elektrisch). Die durch die obigen experimentelle Behandlung erhaltenen Resultate sind hauptsächlich wie unten. Die jungen Pflanzen auf dem Saatbeete können nicht wachsen oder bald absterben, wenn sie täglich bloss 4 Stunden belichtet werden. 8- bzw. 12-stündige Belichtung während der ganzen Saatbeetperiode verursacht zweimalige Rispenauftreten. 24-stündige Belichtung während 15 Tagen verzögert das Längenwachstum um dieser Zeit, während 5-stündige es beschleunigt dagegen. Die fortgesetzt der Langtagbelichtung ausgesetzten Pflanzen gedeihen sehr mächtig, während bei den fortgesetzt der Kurzbelichtung ausgesetzten das ganze Gedeihen sowie das Längenwachstum geschädigt werden. Wenn die Pflanzen zur Zeit des Längenwachstums (15 Tage) oder zu derselben der Körnerentwicklung der 24-stündigen Belichtung ausgesetzt werden, verzögert sich die Körnerreife so bedeutend, dass die Zeit der Vollreife sich nicht mehr bestimmen lässt. Damit ist der Körnerertrag verringert, doch steigert die Strohproduktion.

8- oder 12-stündige tägliche Belichtung beschleunigt das Rispenauftreten, besonders so, wenn diese Behandlung von der Aussaat- bis zur Blütezeit dauert.

Wenn eine Pflanze einige Jahre hindurch der 24-stündigen Belichtung ausgesetzt wird, so ist sie während dieser Zeit unfähig, Rispen auszustrecken, wenn sie doch einigen Jahren unter normaler Belichtungsverhältnis zurückgebracht werden wird, wird sie wieder normalerweise sich verhalten können.



**129. Die geeignete Menge des Pulvers zur Ausführung der Pulvermethode mit kleinerem Messungsfehler.** (Japanisch m. deutsch. Zfg.). Riichiro KÔKETSU. (Bult. Sc. Fac. Terk. Kjušu Imp. Univ. **4**, 1931, 227-243).

Um den bei der Verf.s Pulvermethode unvermeidlichen Messungsfehler, wenn er dabei nicht allzugross sein mag, möglichst zu verringern, hat der Verf. die speziellen Experimente ausgeführt. Damit konnte er schliessen, dass wenn man die Menge des gemessenen Pulvers auf 3-10 ccm beschränkt, der Messungsfehler am kleinsten ist. Es ist empfehlenswert, bei der Volummessung einen Messungszyylinder mit kleinem Durchmesser zu gebrauchen.

**130. Über die Veränderung der Flächendimension und die dadurch verursachte Ungenauigkeit der auf die Flächeneinheit bezogenen Rechnung der Grösse einer physiologischen Eigenschaft der Blätter.** (Japanisch m. deutsch. Zfg.). Riichiro KÔKETSU. (Bot. Mag. Tôkyô **46**, 1932, 124-134).

Die Flächendimension eines Blattes ist variabel nach dem umgebenden Wasser-verhältnis, sodass die vergleichenden Studien der Blätter unter verschiedenen Wasser-verhältnissen (z.B. Stoffgehalt pro Blatteinheit) unvermeidlich zum mehr oder minder grossen Fehler führen muss. Um ihn zu vermeiden muss der Formel  $R_s = R \pm dR$  gebraucht werden, um es zu korrigieren, wobei  $R_s$  den korrigierten Wert,  $R$  den gefundenen und  $d$  den prozentualen Abweichungsgrad der absoluten oder relativen Grösse der Blattfläche bedeutet. Die absolute Grösse heisst der gemessene Wert der Flächendimension und die relative ihren relativen Wert pro Einheit-Volumen des Gewebepulvers.

**131. The mangrove of Formosa.** (With English résumé). Yushun KUDO, (Bot. Mag. Tôkyô **46**, 1932, 147-157, 4 figs. ; 358).

The distribution of various species of the mangrove vegetation in Formosa is discussed. Then follows the enumeration of the species. Rhizophoraceae: *Ceriops*, *Rhizophora*, *Kandelia*, *Bruguiera*. Combretaceae: *Lumnitzera*. Verbenaceae: *Avicennia*. The adaptations are shortly discussed under the titles, fixation, respiratory root, and vivipary.

**132. Genus novum menispermacearum japonicarum.** Yushun KUDO et Yoshimatsu YAMAMOTO. (Bot. Mag. Tôkyô **46**, 1932, 157-159).

A genus *Paracyclea* belonging to the Menispermaceae is created. It contains 2 species, viz. *P. insularis* and *Ochiaiana*, found in Formosa and Southern Kyûsyû.

**133. Morphological studies of *Anemonopsis*, *Actaea* and *Cimicifuga*.** Masao KUMAZAWA. (Jour. Fac. Sc., Imp. Univ. Tôkyô **2**, 1932, 413-454, 21 text-figs.).

Adult plants of the genus *Anemonopsis*, *Actaea* and *Cimicifuga* have few cauline and radical leaves (in *Actaea* no radical foliar leaf). In the stem the phyllotaxis is 1/2 but in the inflorescence 1/3 - 13/34. The foliar leaves are derived from the simple trilobed palmate type, and the transitional process from ternate to biternate was traced in a stump of *C. japonica* var. *biternata*. All the floral elements, except

carpels, are arranged in the FIBONACCI-spiral in *Anemonopsis*, for instance, 21 and 13 parastichies. In *Cimicifuga* and *Actaea* the stamens, though arranged somewhat spirally, are irregular in their arrangement, and never in FIBONACCI's phyllotaxis. According to the author's view *Anemonopsis* is most primitive concerning the floral structure, and *C. japonica* may be derived from it. The medullary bundles are found in the stem of *Anemonopsis* and *C. japonica*. They are generally represented by the leaf trace strands. The author describes the vascular behaviour in the inflorescence of *Cimicifuga* and *Actaea* which is unique and differs very much from that in the stem, for all of which the readers should consult the original. (S. also the following No.).

**134. The medullary bundle system in the Ranunculaceae and allied plants.** (Japanese with English résumé). Masao KUMAZAWA. (Bot. Mag. Tôkyô 46, 1932, 237-331, 1 figure-group, 260-261).

The author's summary in his own words is as follows :

1. Among ranunculaceous and allied plants, medullary bundles are found in the aerial stem of following species or genera : *Thalictrum* spp., *Delphinium* spp., *Anemone japonica*, *A. vitifolia*, *A. rivularis*, *Ranunculus chinensis*, *Cimicifuga*, *Anemonopsis*, *Glaucidium*, *Hydrastis*, *Podophyllum*, *Diphylleia*.

2. The medullary bundles may be divided into five types in respect to their course and origin.

Type I. Large leaf trace strands become medullary immediately at a node, and descending downwards through the pith migrate gradually to the periphery. Trace strands from the perianth do not enter into the pith :—*Delphinium* spp., *Thalictrum* spp., *Ranunculus chinensis*, *Cimicifuga foetida*, *Anemonopsis*.

Type II. The same type as in I, but trace strands from the perianth enter into the pith. These strands migrate outwards in the lower internode :—*Anemone japonica*, *A. vitifolia*, *Glaucidium*.

Type III. Leaf trace strands descend throughout the first internode in the ordinary circle of the bundles and then enter into the pith in the second internode :—*Hydrastis*.

Type IV. Trace strands from the perianth occupy the central part of the pith throughout the stem :—*Podophyllum peltatum*, *Diphylleia Grayi*.

Type V. Leaf trace strands are in periphery, the cauline bundles and the bundles from lateral shoots are in rather medullary part of the stem, being dominant in size :—*Cimicifuga japonica*.

3. The differences of these types may or may not show the systematic affinities.

4. The amplification of the leaf trace makes the medullary bundles indicated by the types I to IV differentiate, while the reduction causes type V to appear. The type I derived probably from the ordinary dicotyledonous type, represents the most primary type, from which the type II may be derived. Types III and IV seem to be developed through the type II in two different directions, the former probably being reduced in the direction of the type I.

**135. The host-parasite relationship in *Olpidium*.** Shunsuke KUSANO. (Jour. Coll. Agric. Imp. Univ. Tokyo **11**, 1932, 359-426, 10 text-figs.).

*Olpidium Viciae* and *O. Trifolii* parasitic on *Vicia unijuga* and *Trifolium repens* respectively in nature were found by means of artificial inoculation, to infect various other phanerogams, resulting in the formation of tumour in one case, while in other case the hosts themselves exhibit no external sign of disease, though they may transmit it to others.

All parenchymatous cells of the host are liable to be infected, and positively chemotactic towards swarm-cells of the fungi. Further, it was found that potassium compounds act positively chemotactic towards them. A thick-walled cell remains uninfected because it prevents the passage of potassium compounds contained in it outwards. Some plants may even secrete certain substances injurious towards the invader. According to the author's view all plant cells contain potassium compounds, and consequently are prone to attract the invading fungi, and the resistance of unsusceptible plants is made possible by such mechanisms, as just pointed out.

**136. Dormancy in the summer sorus of *Synchytrium*.** Shunsuke KUSANO. (Jour. Coll. Agric. Imp. Univ. Tokyo **11**, 1932, 427-439, 2 text-figs.).

In *Synchytrium minutum* parasitic on *Pueraria Thunbergiana* the sori lie deeply imbedded in the tumour tissue, and remain undehisced during the year of formation. On the approach of winter the host perishes except its lower part. In the next spring the tumour bursts in virtue of its tissue tension, so as to disperse gametangia in pulverous form. In *S. aecioides* parasitic on *Amphicarpaea japonica*, on the contrary, as all parts of the host die away wholly in winter, the sori will dehisce in the next spring by their own action, perhaps by producing certain osmotic substance which absorb water.

The summer sori of *S. minutum* formed on leaves of *Pueraria Thunbergiana* become mature three or four weeks after infection and soon dehisce, but those occurring on stems are generally much delayed in their maturity. Thus though the infection takes place in early spring, the sori are completed first in January of the next year, and the full maturity in pulverous form is first attained in February, so that it may be said that no dormant period in strict sense does exist. As the consequence of such a long delay the tumour may grow considerably.

The hibernation of summer sori during a long period and the reappearance of fungus from them in the next spring, coupled with the fact that the resting cell was never observed before, led the author to the conclusion that the sexual reproduction to form the resting cell is wanting in the fungus under discussion.

**137. The double coiled spiral structure of chromosomes.** (Japanese with English résumé). Yoshinari KUWADA. (Bot. Mag. Tôkyô **46**, 1932, 307-310, 1 pl.; 257-358).

The double coiled spiral or spiral-within-spiral structure of chromosomes in *Tradescantia virginica* already seen by another author has been again observed by the author himself in the heterotype division of pollen mother-cells by means of a new



method. In this plant the portion where one chromosome is linked with another often shows that the spiral of the higher order is double in the metaphase, consisting of two of the spirals of the lower order which may separate from each other to a certain extent in the anaphase. The coiled thread of chromonema was traced to the interphasic state of the nucleus.

Similar structure was seen by SHINKE in some other plants, as *Sagittaria*, *Lilium* and *Hosta*.

**138. A new species of *Equisetum*.** (With Japanese résumé). Fumio MAEKAWA. (Bot. Mag. Tôkyô **46**, 1932, 188-191, 3 text-figs.; 366-367).

A new species *Equisetum ripense* was found in Nikkô. The anatomical study of stem and stomata was made. Basing on its anatomical structure, the author ranks it among a distinct group within the section Hippochaete which comprises *E. ramosissimum* and *Sieboldii*. It is high, and often attains 1.8 m.

**139. A contribution to the phytogeography of the Island of Yakusima II** (Angiospermae). (Japanese with English résumé). Genkei MASAMUNE. (Bot. Mag. Tôkyô **46**, 1932, 286-292, 256-257).

Comparative studies of various genera of plants in the Yakusima Island (Southern Japan) with those in the other southern and the northern districts has led the author to the following main conclusions.

I. The Compositae, Rubiaceae, Gesneriaceae, Gentianaceae, Melastomataceae, Myrtaceae, Euphorbiaceae, Leguminosae, and the Amarantaceae bear much more relation to those of the southern districts than to those of the northern ones.

II. The Caprifoliaceae, Scrophulariaceae, Ericaceae, Clethraceae, Cornaceae, Umbelliferae, Camelliaceae, Rosaceae, Podostemonaceae, Caryophyllaceae, Liliaceae, and the Gramineae have much more relation to those of the northern districts than to those of the other districts.

III. All the remaining families do not show any affinity either to those of the northern districts.

**140. Contribution to our knowledge of the flora of the southern part of Japan VIII.** (With Japanese résumé). Genkei MASAMUNE. (Jour. Soc. Trop. Agric. **4**, 1932, 76-78).

9 species, incl. new species, variety, forma and new combinations are described. The following are new and described. *Chamaele decumbens* MAKINO var. *micrantha* (var. nov.), *Crawfordia japonica* SIEB. et ZUCC. var. *tenuis* (var. nov.), *Dryopteris yaku-montana* sp. nov., *Carex yakusimensis* sp. nov., *Scabiosa lacerifolia* HAYATA f. *leucantha* f. nov., *Mitella formosana* (HAY.) comb. nov., *Potentilla tugitakensis* sp. nov.

**141. Effect of seed-formation on the rate of respiration of the Japanese persimmon or kaki (*Diospyros Kaki* L. fil.).** Kumaichi MATSUMOTO. (Japan. Jour. Bot. **6**, 1932, 125-137, 1 text-fig.).



**142. On the relationship between the serological reaction and other biological characters of some putrefactive phytopathogenic bacteria.** Takashi MATSUMOTO and Kôetsu SOMAZAWA. (Jour. Soc. Trop. Agric. **3**, 1931, 317-336).

The causal organism of soft rot disease of *Brassica pekinensis*, provisionally referred to as No. 216 and others referred to as Nos. 197, 201, 204 and 216 which are included under the same serological group are culturally more closely related to each other than to any of the strains of different serological type. They are peritrichally flagellate and morphologically closely related to each other, except No. 204 which is somewhat broader than any other.

Nos. 204, 212, and 216 are closely related to each other on the basis of the agglutinin absorption. No. 201 shows the incomplete agglutinin absorption, and yet it is more closely related in some particulars to No. 216 than to No. 204. The incomplete agglutinin absorption of No. 201 might be due to the weak antigenic property, and will not prevent for placing it under the same serological group as No. 216. No. 174 (type strain of *Bacillus aroideae*) is culturally and morphologically quite identical with any member of the above mentioned group, so that the inagglutinability of this strain will not suffice to separate it from the others, inasmuch as certain strains which are antigenically inactive do not react even with the sera of closely related species.

The general conclusion from all above data obtained by the authors is that though the serological reaction has served for differentiating various phytopathogenic bacteria as well as for identifying homologous antigens, yet this would be no means warrant using the tests as the basis for classifying the organisms under question, because the failure of the agglutination will not be proof of specific distinction.

**143. On the cell-wall constituents of brown algae.** (Japanese with English résumé). Tomowo MIWA. (Bot. Mag. Tôkyô **46**, 1932, 339-344, 261-262).

The cell-wall of brown algae was hitherto generally considered not to be constituted of the genuine cellulose. The author has however found it to be composed of real cellulose in the inner layer bordering on cytoplasm and alginic acid in the middle lamella.

The cellulose nature was established by means of acetolysis, the octacetyl cellulose being produced as the cleavage product. Alginic acid, a polymerized mannuronic anhydride which is the chief constituent of the cell-wall of brown algae, was claimed by KYLIN to occur solely as calcium salt, but the author has shown that its greater part does not exist as such, though the presence of Ca is essential for the maintenance of the structural stability of the cell-wall in brown algae. Fucinic acid is readily converted into alginic acid by the use of alcohol containing little HCl. Both yield mannuronic acid by hydrolysis.

**144. Flora of Hokkaido and Saghalien III. Monocotyledoneae (Araceae to Orchidaceae).** Kingo MIYABE and Yushun KUDO. (Jour. Fac. Agric. Hokkaido Imp. Univ. **26**, 1932, 279-387, 1 pl. and 1 text-fig.).

This part contains Nos. 536-768 and ends the Monocotyledons. The families included in this part are Araceae, Lemnaceae, Eriocaulaceae, Commelinaceae, Potentilla-

aceae, Juncaceae, Liliaceae, Amaryllidaceae, Dioscoreaceae, Iridaceae, and Orchidaceae. *Smilacina trinervis* (new sp.) and *Luzula Jimboi* are described.

**145. *Cymathere crassifolia* (POSTELS et RUPRECHT) DE TONI from the Southern Kuriles.** Kingo MIYABE and Masaji NAGAI. (Proc. Imp. Acad. 8, 1932, 123-126, 4 text-figs.).

*Cymathere crassifolia*, first named *Laminaria crassifolia* by POSTELS and RUPRECHT basing on a single old specimen, was never collected again till now. The junior author has found again unexpectedly this species on the eastern coast of Kunasiri, the southernmost island of the Kuriles in 1928 and 1930. Its description is given.

**146. *Pleuropterum paradiseum*, a new genus and species of Alarieae from the Northern Kuriles.** Kingo MIYABE and Masaji NAGAI. (Proc. Imp. Acad. 8, 1932 127-130, 2 text-figs.).

The diagnosis of the new genus *Pleuropterum* and that of the new species *P. paradiseum* are given.

**147. On the Matusima variegation in Japanese morning glory.** (Japanese with English résumé). Bungo MIYAZAWA. (Bull. Miyazaki Coll. Agric. & For. No. 4, 1932, 111-125).

The author has repeated his experiments on the Matusima variegation in the Japanese morning glory (s. Japan. Jour. Bot. 5, (3), No. 45), and fully confirmed the results of his former experiments. The main conclusions attained by these repeated experiments are as follows. The yellow plants always segregate out green, variegated and yellow offspring, and consequently may be considered genetically as the variegated strain. The green constant plants may be obtained. The inconstancy of the variegated is due to the constant occurrence of the gene transformation of yellow to green. Though IMAI considers the Matusima variegation as a periclinal chimera, the author cannot agree with him, since no phenomena similar to those occurring in the chimerae, such as in those of *Pelargonium*, *Veronica*, *Antirrhinum*, *Hydrangea*, *Spiraea*, etc. are observed in the variegated plant under discussion.

**148. On the two cases of semi-sterility in *Oryza sativa*.** (With Japanese résumé). Bungo MIYAZAWA. (Bull. Miyazaki Coll. Agric. and For. No. 4, 192, 193-197, 2 text-figs.).

In one of the two strains mentioned in this paper the paleas remain open after flowering, and a few ripe grains are obtainable; the transmission of this property to the offspring of the next year was seen by the author. In this strain, within the ordinary paleas there are 2-4 secondary paleas, evidently derived from the lodiculæ which prevent the closure of paleas once opened. Stamens and pistils are incomplete. In another strain nearly similar externally to the former the pistil has always three stigmas. In still another strain which is also semi-sterile the grains, if developed at all, are triangular, and the inner palea is generally small and slender.

**149. The chlorophyll deficiencies in rice.** Toshitaro MORINAGA. (Bot. Mag. Tôkyô 46, 1932, 202-207).

The cross of 4 *chlorina* varieties with normal one has given in each case the normal  $F_1$  plant which has shown in  $F_2$  the monogenic segregation. Among 5 variegated strains studied by the author 3 varieties were known by the crossing method to follow the simple Mendelian scheme. The remaining two are evidently non-Mendelian: the cross with a normal variety shows maternal inheritance, giving rise either to green self-coloured or striped, which on selfing will give green or striped and albino offspring in irregular proportion respectively.

Another strain was found, which by selfing produces green and non-viable albino in almost 3:1 proportion. In still another strain the author has observed in some  $F_2$ -lines the segregation into green and yellow, both into 15:1 and 3:1 proportions. Few other miscellaneous observations are recorded.

**150. Studies on the Japanese Saprolegniaceae.** Masaji NAGAI. (Jour. Fac. Agric., Hokkaido Imp. Univ. **32**, 1931, 1-43, 7 pls.).

With few exceptions all Saprolegniaceae enumerated in this paper are those isolated in pure state by the author from a single spore, sporangium, gemma or a piece of hypha, and cultivated in a certain medium. They belong to the genera *Pythopsis* (1 sp.), *Saprolegnia* (6 sp.), *Isoachlya* (2 sp.), *Achlya* (9 sp.), ? *Traustotheca* (1 sp.), *Dictyuchus* (2 sp.), *Leptolegnia* (1 sp.) and *Aphanomyces* (1 sp.). The following are new: *Isoachlya Itoana*, *Achlya Oryzae*, *A. flexuosa*, *Dictyuchus anomalus*.

All species are described, and the keys for the determination of the genera and species are given.

**151. Über das Verhalten von *Polyporus Schweinitzii* FR. in Mischkulturen.** (Japanese). Isamu NAGATOMO. (Forsch. a. d. Geb. d. Pflanzenkrank. **1**, 1931, 192-204, 2 pls.).

The mixed culture of *Polyporus Schweinitzii* on the agar medium together with a number of other fungi was performed to observe their behaviour towards each other. A few instances may here be noticed. In the mixed culture of *P. Schweinitzii* and *P. orientalis* in darkness the latter was overgrown by the former, while cultivated under light condition, each of them stops its respective growth on approaching. The author has observed also in dark culture that each of *Fomes applanatus*, *F. pinicola*, *F. ulmarius*, and *Polyporus japonicus* is overgrown by *P. Schweinitzii*.

**152. Notulae ad plantas japonicae and koreae XLI.** (Also in Japanese). Takenoshin NAKAI. (Bot. Mag. Tôkyô **46**, 1932, 37-67, 89-101).

The following new species (either by the author alone or in common with MAKINO) are described among others. *Sasamorpha amabilis*, *S. chiisanensis*, *S. gracilis*, *S. mollis*, *Sasa kogasensis*, *S. mollis*, *S. tenuissima*, *S. gracillima*, *S. kiyozumina*, *S. yamatensis*, *S. villosa*, *Silene Harai*, *Thalictrum supradecompositum*, *Draba yesoensis*, *Mucuna japonica*, *Primula sachalinensis*, *T. coreanum*.

**153. *Hemerocallis japonica*.** (With Japanese résumé). Takenoshin NAKAI. (Bot. Mag. Tôkyô **46**, 1932, 3 text-figs., 135-137).



*Hemerocallis* is divided into six sections, viz. Aurantiacae, Fulvae, Capitatae, Anthelatae, Flavae and Citrinae. 13 species are arranged under them, of which the following two are new species, viz. *H. sulphurea* and *coreana*.

**154. On the inheritance of anthocyan formation in rice, with special reference to the colour of stigma.** (Japanese). K. NAKAYAMA. (Japan. Jour. Gen. 7, 1932, 153-160).

The anthocyanin formation in rice plants, as studied by the author, is due to the combined action of two factors so far as it concerns stigma, glume-tip, awn and outer glume; it is due to that of three factors concerning leaf-blade, upper surface of leaf-sheath, node, ligule, auricle, etc.

In plants with purple leaf-blade and upper surface of leaf-sheath, the stigma and glume-tip are always coloured. The purple colour of ligule and auricle goes always hand in hand with that of leaf-blade and leaf-sheath.

**155. The segregation in the size of grains in the cross between normal and dwarf races of rice.** (Japanese). K. NAKAYAMA. (Japan. Jour. Gen. 7, 1932, 161-171, 3 text-figs.).

In a cross between normal and dwarf variety of rice the author has made the measurement of the size as well as form ( $\frac{\text{short diameter}}{\text{long}}$ ). It was found that normal type is almost perfectly dominant to the dwarf, no intermediate one being observed. Neither the character of endosperm nor the presence or absence of anthocyanin has any relation at all with the size of grain.

**156. Studies on the species crosses of Japanese *Rhododendron*. I. On the crossability between various species and the cotyledon color of  $F_1$  seedlings.** Yakichi NOGUCHI. (Japan. Jour. Bot. 6, 1932, 103-124, 2 pls.).

**157. Genetic studies on *Platycodon*.** (With Japanese résumé). Sigeroku NOHARA. (Bot. Mag. Tôkyô 46, 1932, 192-201, 1 fig. 367-368).

In *Platycodon grandiflorum* there are a number of strains, viz. deep or pale purple, white, variegated, single or double, etc. The results of the author here propounded are based on the cross, a strain with deep purple single flower  $\times$  that with white double one. The former is genetically *PPSS* and the latter *ppss*, and the complete dominancy of one over the other is observed. The formation of pale purple strain is not due to any combination of factors resulting from a certain hybridization, but it is to be regarded as having been produced by a factor mutation of white, i.e. that going from recessive to dominant.

**158. Studien über *Polyporus japonicus* FRIES.** (Japanisch). Tomowo NOJIMA. (Forsch. a. d. Geb. d. Pflanzenkrank. 1, 1931, 175-191, 1 Taf. und 4 Textabb.).

Eine Beobachtung über die von *Polyporus japonicus* infizierten Wurzeln einer *Quercus*-art sowie die künstliche Infektion haben es gezeigt, dass die Myzelien dieses



Pilzes direkt die Zellulosemembranen verschiedener Zellarten im Holzteile durchbohren und auch durch die Poren der Gefäße um die Markstrahlerzellen in verschiedener Richtungen auswandern können. Die mikrochemische Untersuchung der nach der künstlichen Infektion zur Fäulnis übergegangenen *Quercus*holzes hat es gezeigt, dass unser Pilz ein ligninauflösender ist und die Zellulosesubstanz nachlässt ("white spongy rot"). Die Kultur auf Kartoffeldekotagar sowie verdünntes Sojaagar hat die guten Resultate gegeben. Das Wachstum findet zwischen 24–36°C statt. Die Kultur auf Sägespäähne ohne oder mit dem Holzstücke von *Quercus glauca* in dem ERLÉNMEYERS Kolben wurde vom Verf. ausgeführt, wobei er zahlreiche Hutstiele und selten kleine Hüte bekommen hat.

**159. On the structure and affinities of some cretaceous plants from Hokkaido. Second contribution.** Yudzuru OGURA. (Jour. Fac. Sc., Imp. Univ. Tokyo Sec. III, 2, 1932, 455–483, 3 pls. and 16 text-figs.).

The following cretaceous plants collected from the Yûbari and Ikusyunbetu districts in Hokkaido are described under the following sub-titles, diagnosis, material, internal structure, affinity, and sometimes reconstruction, with illustrations: *Cycadanium compactum*, *Stachycarpus projectus*, *Piceophyllum simplex*, *Yubaria invaginata*, *Pinus flabellifolia*, *P. pseudostrobinifolia*, *Sciadopitys cretacea*, all of which are new species and the first four at the same time the new genera.

**160. Über die Zersetzung der Holzzellwände durch Pilzfäden.** (Japanisch m. deutsch. Zfg.). Kametaro OHARA und Kôtarô ADACHI. (Bot. Mag. Tôkyô 46, 1932, 345–352, 1 Taf. und 1 Textabb., 262–263).

Als Untersuchungsobjekt dienten die von *Trametes Pini* angegriffenen Hölzer von *Picea jesoensis* sowie die durch *Fomes ulmarius* angegriffenen von *Cryptomeria japonica*. Durch die Behandlung der obenerwähnten Hölzer mit Chlorzinkjod,  $H_2SO_4 + J$  und Phloroglucin-Salzsäure konnten die Verf. sich davon überzeugen, dass in der Umgebung der Pilzbohrlöcher keine besondere topographische Veränderung der Zellwandstruktur eingetreten ist. Gewisse Farbstoffe, z.B. Hämatoxylin und Rutheniumrot färben die Zellwände des Holzes um die Pilzbohrlöcher, wenn sie durch Methylenblau und Thionin ganz ungefärbt bleiben. Diese eigentümliche Randzone wird durch Oxaminblau 4R blau gefärbt, während die übrigen Teile sich rot färben, sodass die metachromatische Färbung deutlich ist. Aus dem soeben erwähnten wurde es jedenfalls festgestellt, dass die Zellwände in der Umgebung der Pilzbohrlöcher eine Veränderung des submikroskopischen Gefüges zeigen.

**161. Cytological studies on *Sciaphila japonica*, MAK. (Prel. note). II. On pollen- and embryo-sac-development. III. Mycorrhiza.** (Japanese). Ichiro OHGA and Yosito SINÔTÔ. (Bot. Mag. Tôkyô 46, 1932, 311–315, 34 text-figs.).

The reduction division in pollen- as well as embryo-sac mother-cell of *Sciaphila japonica* goes quite normally. The cells of cortical layer of the root is filled with fungal hyphae, and in such cells the nuclei are large and have an abundance of chromatin grains.

**162. Contributiones ad carilogiam Asiae orientalis. Pars altera.** Jisaburo OHWI. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B, **6**, 1931, 230-270).

Among others the following new species of *Carex* are described: *C. phaeothrix*, *ochrochlamys*, *atroviridis*, *sozusensis*, *tumidula*, *fusco-fibrosa*, *senanensis*, *impura*, *cuneata*, *praestabilis*, *ouensanensis*, *graciliculis*, and *Yoshinoi*.

Also a number of new varieties are contained in this paper.

**163. Florula shikotanensis.** (With Japanese introduction). Jisaburo OHWI. (Acta Phytotax. et Geobot. **1**, 1932, 34-55).

The plants collected in Sikotan, one of the Kurile Islands, are enumerated. The names of 161 plants are given in this part. The "Florula" will be continued.

**164. Mitella of Japan.** (With Japanese résumé). Jisaburo OHWI. (Acta Phytotax. et Geobot. **1**, 1932, 64-65).

8 species of *Mitella* are enumerated, of which *M. obconica* is new. The key for the determination of species is given.

**165. Symbolae ad floram Asiae orientalis. IV.** (With Japanese résumé). Jisaburo OHWI. (Acta Phytotax. et Geobot. **1**, 1932, 66-87).

The following are new: *Leipoa blepharogyna* (gen. nov., sp. nov.), (Gramineae-Festucaceae), *Carex tsushimensis*, *C. phaeoleuca*, *C. yamatsutana*, *C. pleiandra*, *C. chosenica*, *C. fusanensis*, *C. subtumida*, *C. rugata*, *Scirpus orientalis*, *Fimbristylis Fauriei*, *F. Koidzumiana*, *Scleria Fauriei*, *Luzula formosana*, *Isopyrum yamatsutanum*, *Pyrola macrocalyx*.

**166. On the rôle of microorganism in the digestion of insect bodies in insectivorous plants.** (Japanese with English résumé). Kunio OKAHARA. (Bot. Mag. Tôkyô **46**, 1932, 353-357. 263).

From the leaves of *Drosera rotundifolia* and the pitchers of *Nepenthes mirabilis* a great number of microorganisms, including bacteria and fungi were isolated. Many of them were observed to decompose peptones with simultaneous formation of ammonia. The author comes to the conclusion that in such insectivorous plants the protein is first decomposed to peptones and albumoses by pepsin-like enzymes, and the peptones and albumoses are attacked by such microorganisms causing the desamination, as may be seen from the ammonia-production.

**167. The distribution of marine algae in Pacific waters.** K. OKAMURA. (Rec. Oceanogr. Works in Japan **4**, 1932, 30-150).

Concerning the distribution of marine algae (except the Cyanophyceae) the Pacific region was divided into seven regions, viz. Japan, Behring Sea, America, Australia, Malay Archipelago, China Sea and Polynesia. The number of the Chloro-, Phaeo- and Rhodophyceae in each of seven regions is shown in several tables. Then follows the literature. The paper ends with the enumeration of 3794 species of marine algae in the Pacific waters and the distribution of each of them.

**168. Polyploidy in *Rumex Acetosa*.** (Japanese with English résumé). Tomowo ONO. (Bot. Mag. Tôkyô **46**, 1932, 321-327, 34 text-figs.).

The relation between the polyploidy and the sex in *Rumex Acetosa* agrees with that seen in *Drosophila*. In polyploid plants the external differences accompany the increase of chromosome number. The meiosis in the P.M.C. of triploid and tetraploid plants is described.

**169. Beobachtungen über japanische Moosflora. (I).** K. SAKURAI. (Bot. Mag. Tôkyô **46**, 1923, 375-384).

Die von Y. DOI in Südkyûsyû gesammelten Moose sind in diesem Aufsatz erwähnt. Die folgenden sind neu und beschrieben: *Piltrichopsis erecta*, *Neckeraopsis kiusiana*, *Cyatophorella Doii*, *Schwetschkea kiusiana*, *Fabronia formosana*, *Claopodium kiusiense*, *Hygrohypnum Doii*, *H. kiusianum*, *Platyhypnum delicatum*, *Brachythecium kiusianum*, *Clastobryella Shiicola*, *Brotherella barbelloides*, *Trichosteleum flagelliferum*, *Homomallium kiusiense*, *H. Doii*, *H. leskeoides*.

**170. Juncaceae of the Aleutian Islands collected by Mr. Y. KOBAYASI in 1931.** (With Japanese résumé). Yosisuke SATAKE. (Bot. Mag. Tôkyô **46**, 1932, 185-187, 364-365).

The enumeration contains 6 species of *Juncus* and 6 species of *Luzula*.

**171. Studien über die Wirkungen der durch *Ophiobolus Miyabeanus* gebrauchten Nährlösungen auf die Keimung und Entwicklung eines andern Pilzes.** (Japanisch m. deutsch. Zfg.). Seiichi SATOH. (Forsch. a. d. Geb. d. Pflanzenkrankh. **1**, 1931, 71-85 m. 2 graph. Darst.).

In der Kulturflüssigkeit von *Ophiobolus Miyabeanus* werden zweierlei Arten von Stoffen gebildet, von denen eine das Wachstum von *Aspergillus niger* beschleunigt und die andere es hemmt. Beide sind leicht voneinander auszutrennen: denn 1. der letztere wird durch das CHAMBERLANDS Tonfilter durchgelassen und der erstere dadurch zurückgehalten, 2. bei der Verdünnung der gebrauchten Lösung geht die hemmende Wirkung leichter verloren als die beschleunigende und 3. die hemmende Substanz wird durch Wärme zerstört und die beschleunigende ist dagegen widerstandsfähig. Die Reizwirkung ist bei beiden stärker in der ersten Woche als in der folgenden.

**172. Über die Verarbeitung der Zellulose durch einige krankheitserregende Pilze.** (Mit japan. Zfg.). Seiichi SATOH. (Forsch. a. d. Geb. d. Pflanzenkrankh. **1**, 1931, 1931, 13-20, 4 Textabb.).

Die zelluloseauflösende Wirkung bei den folgenden Pilzen wurde sicher nachgewiesen, nämlich *Piricularia Oryzae*, *Ophiobolus Miyabeanus*, *Helminthosporium* sp., *Fusarium* (2 Kultursippen), *Gibberella Saubinetii*, *Rhizoctonia Papayae*.

**173. Studies on the summer and winter forms in barley. I. On the difference in susceptibility to illumination.** (Japanese). Kenkiti SATÔ and Hirosada YUMIYAMA. (Ann. Agric. Expt. Sta. Gov.-Gen. Chosen (Tyôsen) **6**, 1932, 1-24, 1 pl.).



In barley, whether it may belong to winter, summer or intermediate type, the long illumination always accelerates the heading time, while the short one retards it (so-called long day plant). This is especially the case in two latter types. Furthermore, though in spring time when the air temperature is comparatively high, the difference of the reaction of the spring and the intermediate forms towards long illumination is very slight, in autumn, when the air temperature is comparatively low, the intermediate type will react more considerably than the spring one. This remarkable difference seems to be quite natural when the fact is taken into consideration that the former being relatively winter-hardy can react well even under low temperature, while the spring form which is less winter-hardy cannot.

The longitudinal growth of the spring and intermediate forms is accelerated or retarded by long and short illumination respectively, while just the contrary is the case in the winter one.

**174. Chromosome studies in *Lilium*, I.** Masayosi SATÔ. (Bot. Mag. Tôkyô 46, 1932, 68-88, 26 text-figs.).

Among eighteen species of *Lilium* examined by the author the somatic number of chromosomes is 24 in sixteen while it is 26 and 36 in *L. japonicum* and *L. tigrinum* var. *flore-pleno* respectively. The latter may be regarded as a triploid form of *L. tigrinum*. In *L. japonicum* 2 among 26 chromosomes are markedly smaller than the others, and may be considered as the fragments formed as the result of segmentation at the points of constriction or transverse suture.

The length of each chromosome in any somatic cell, for example, root-tip cell, is various, though its breadth is nearly the same. The chromosome length in absolute number and percentage in *L. philippinense* var. *formosanum*, *L. japonicum* and *L. speciosum* are given in the tables, and their relative lengths are shown diagrammatically. It was seen that in each of them there is always a constant difference among the lengths of its chromosomes. It is also to be remarked that the total lengths of all chromosomes contained in one cell of each of three above mentioned is nearly equal (e.g. 344,2, 346,9, 348,5 respectively). It was further noticed that the length of each chromosome to the total lengths of all chromosomes in one cell, expressed in %, is nearly of the same value in each of these three species.

**175. Experimentelle Untersuchungen über die hemmende und die beschleunigende Wirkung des Erregers der sog. "Bakanae"-Krankheit, *Lisea Fujikuroi* SAWADA, auf das Wachstum der Reiskeimlinge.** Fusataro SETO. (Mem. Coll. Agric., Kyoto Imp. Univ. No. 18, 1932, 23 S., 1 Taf.).

Der Einfluss der Kulturfiltrate des Erregers der Bakanae-Krankheit der Reiskeimlinge wurde von dem Verf. eingehend untersucht, wobei die Ergebnisse keineswegs einheitlich waren. Die das Wachstum fördernden sowie es hemmenden Wirkungen können durch ein und dieselbe Kulturrasse herbeigeführt werden. In der Natur zeigt der eine Typus der Bakanae-Keimlinge ein gehemmtes Wachstum und auffällig vergilbende Blätter, während der andere gut aussieht und anscheinend krankheitsfrei ist.



**176. Studien über die Bildung organischer Säuren bei *Begonia Evansiana* ANDR.** (Japanisch m. deutsch. Zfg.). Mannen SHIBATA. (Bot. Mag. Tôkyô **46**, 1932, 333-338, 261, 4 Textabb.).

Die Oxalsäureproduktion wurde an *Begonia Evansiana* mittels des etwas modifizierten KLEIN-WERNERS Apparates (vgl. KLEIN u. WERNER, Zeits. f. physik. Chem. **143**, 1925, S. 141) untersucht. Die hauptsächlichlichen Ergebnisse sind die folgenden.

Ausgenommen die Bulbillen und Knollen, ist nur Oxalsäure in allen Teilen der obengenannten Pflanze nachweisbar, und zwar reichlicher in Blattspreite. Er nimmt der Reihe nach von den unteren Knoten her nach den oberen ab, während in den Knoten selbst des Verhältnis ganz umgekehrt ist. Es wurde ferner nachgewiesen, dass bei den während langer Zeit in CO<sub>2</sub>-freier Luft kultivierten Pflanzen der Säuregehalt, beide in den Blattstiel- sowie -spreiten, bedeutend zunimmt, wenn auch die ursächliche Beziehung zwischen beiden noch zu erforschen bleibt.

**177. Studien über die Bildung organischer Säuren. I. Die Reihenfolge des Säuregehalts im ganzen Körper in *Begonia Evansiana* ANDR.** Mannen SHIBATA. (Sc. Repts. Tôhoku Imp. Univ. 4th Ser., **7**, 1932, 157-179, 6 Textabb.).

Ausführliche Angabe des in Nr. 176 referierten Aufsatzes.

**178. Further studies on the nature of the growth-promoting substance excreted by the "bakanae"-fungus.** (With Japan. résumé). Shoichi SHIMADA. (Ann. Phytopathol. Soc. Japan **2**, 1932, 442-452, 1 pl.).

This paper contains the continuation of the author's former work made together with S. ITO on the growth-promoting substance excreted by the bakanae fungus *Gibberella Fujikuroi*. (Cf. Japan. Jour. Bot. **5**, (94), No. 319).

Either the filtrate which was dried up gently or the animal black which absorbed this substance as such or that passed through a semipermeable membrane was treated with distilled water, alcohol, ether, acetone, and chloroform. The growth-promoting substance was thus extracted, though distilled water is of no use in the case when the animal black is used. The experiments with such extracts on the seedlings of wheat, barley, maize, Adzuki bean, and soy bean have shown that the growth-promoting action is also observed here.

**179. Über die Entstehung neuer konstanten fruchtbaren 4n Bastardes bei *Chrysanthemum*.** (Japanisch m. deutsch Zfg.). Naomasa SHIMOTOMAI. (Bot. Mag. Tôkyô **46**, 1932, 316-320, 258-259, 2 Textabb.).—**Bastardierungsversuche bei *Chrysanthemum*. II. Entstehung eines fruchtbaren Bastardes aus der Kreuzung von *C. marginatum* (haploid 5n) mit *C. morifolium* (hapl. 3n).** Ders. Autor. (Jour. Sc. Hiroshima Univ. Ser. B, Div. **2**, 1, 1932, 115-120, 8 Textabb.).

Der in obigem Titel genannte F<sub>1</sub>-Bastard, der 72 diploide Chromosomen aufweist (Eltern 45 und 27 haploid) zeigt eine ganz regelmässige meiotische Teilung, indem, bei der heterotypischen Teilung die autosyndetische Gemini gebildet werden. Nach Selbstung zeigt er eine hohe Fruchtbarkeit, und die daraus entstandenen F<sub>2</sub>-Pflanzen weisen 72 diploide Chromosomen auf.

**180. Geschlechtschromosomen bei *Pogonatum inflexum* LINDB. und Chromosomenzahlen bei einigen andern Laubmoosen.** Naomasa SHIMOTOMAI. (Jour. Sc. Hiroshima Univ. Ser. B., Div. 2, **1**, 1932, 95-101, 26 Textabb.)(Auch in japanisch m. deutsch. Zfg. in Bot. Mag. Tôkyô **46**, 1932, 386-391, 3 Textabb.).

Der Gametophyt von *Pogonatum inflexum* weist 7 Chromosomen auf. Bei dem weiblichen ist einer derselben viel länger als die andern und durch zwei Einschnürungen ausgezeichnet; es ist als das X-Chromosom zu deuten. Bei dem männlichen dagegen, ist einer derselben sehr klein und als das Y-Chromosom zu betrachten.

Die Erscheinung der Heteropyknose ist bei der betreffenden Art zu beobachten. Bei der heterotypischen Teilung der Sporenmutterzellen bilden je ein X- und Y-Chromosom zusammen ein Geminus, die bei der Anaphase sich auseinander trennen.

Die Chromosomenzahl einiger andern Laubmoose, die 7, 10 11 und 18 beträgt, wird hervorgehoben.

**181. Cytogenetical studies on *Tricyrtis*. I. Chromosomes in *Tricyrtis*. (Preliminary note).** (Japanese). Yosito SINOTÔ and R. KIKKAWA. (Japan. Jour. Gen. **7**, 1932, 1932, 194-198).

In all forms of *Tricyrtis* studied by the authors (6 species, 9 varieties and 2 forms) they found  $n = 13$  and  $2n = 26$ . The chromosome garniture is composed of 2 large, 6 median and 5 small chromosomes. The meiosis of P.M.Z. goes regularly in the variety hybrids as well as in certain species hybrids which are fertile, while in other species hybrids which are quite sterile the meiosis is very irregular.

**182. *Spicilegium pteridographiae Asiae orientalis* I.** (With Japanese résumé). Motozi TAGAWA. (Acta Phytotax. et Geobot. **1**, 1932, 88-94).

The following plants are enumerated among others and described: *Diplazium Mettenianum* (MIQUEL) C. CHR. var. *Fauriei* (CHR.) and var. *isobasis* (CHR.), comb. nov., *Polystichum aculeatum* SCHOTT. var. MAKINOI nom. nov., *P. tripterum* var. *simplicissimum* var. nov., *Dryopteris bukoensis* sp. nov., *P. simplicius* comb. nov., *P. simplicius* var. *majus* var. nov., *P. pseudo-aristatum* sp. nov.

**183. Photographiensammlung der japanischen alpinen Pflanzen.** (Mit japan. Text). II. Reihe, Heft 1-3, Tôkyô 1932. Hisayoshi TAKEDA und Kadzuo TANABE.

Die im obigen Titel genannte Photographiensammlung der japanischen alpinen Pflanzen fingt im vorigen Jahr zu erscheinen an, und die erste Reihe derselben, welche aus 10 Heften besteht, ist schon vollständig. Die jetzt zum Referent zur Verfügung stehenden 1., 2. und 3. Heft der zweiten Reihe bilden die Fortsetzung derselben. Alle Photographien, von denen jede 20,6×15,6 cm beträgt, und die anscheinend am natürlichen Standort der Pflanzen aufgenommen worden sind, sind sehr gut gelungen und auf gutem Papier in feiner Autotypie gedruckt. Jedes Heft, das je 20 Photographien enthält, wird monatlich erscheinen und kostet 2,50 Yen.

**184. The genus *Viola* in Kyûsyû I.** (Japanese). Makoto TAKENOCHI. (Jour. Nat. Hist. Soc. Hukuoka **1**, 1932, 4-8, 1 col. pl.).

2 species of *Viola*, viz. *biflora* and *xanthopetala* are described with coloured illustrations.

**185. Untersuchung über den Einfluss des Welkens auf die Anhäufung der Assimilate in den Blättern durch die Anwendung der "Pulvermethode."** (Japanisch m. deutsch Zfg.). Bun TAMAOKI. (Bult. Sc. Fak. Terk., Kyûsû Imp. Univ. **4**, 1931, 559-569).

Es ist wohl bekannt, dass die Assimilationstätigkeit bedeutend schwächer in den welkenden Blättern als in den normalen ist. Mit Hilfe der Pulvermethode hat der Verf. eine quantitative Schätzung der Assimilate in den Blättern an den verschiedenen Stadien des Welkens studiert. Er hat dabei gefunden, dass im Gegensatz zu den normalen Blättern, wobei die Anhäufung der Assimilate von Morgen bis zum Abend fortdauernd sich vers'ärkt, in den welkenden ihre schwache Anhäufung, ja bisweilen sogar ihre deutliche Verminderung während diesem Zeitdauer zu bemerken ist.

**186. Über die Verwendbarkeit von verschiedenen Kohlenstoffverbindungen im Bau- und Betriebsstoffwechsel der Schimmelpilze. (Studien über die Stoffwechselphysiologie von *Aspergillus oryzae*. IV.)** Hiroshi TAMIYA. (Acta Phytochimica, **6**, 1932, 1-129).

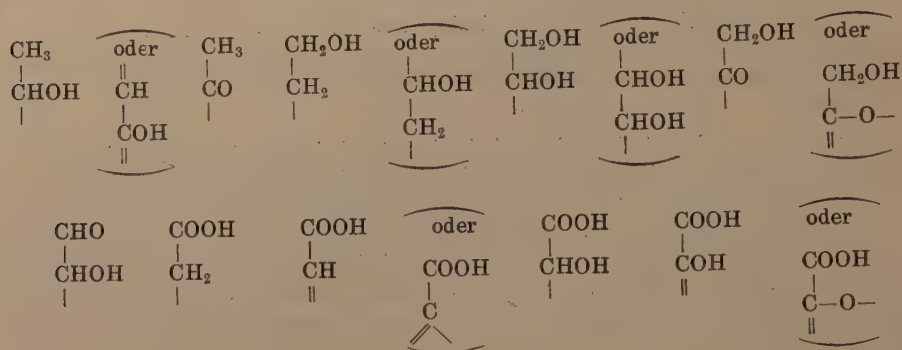
Aufgabe der vorliegenden Arbeit war die Klarlegung der Ausnutzbarkeit von verschiedenen Kohlenstoffverbindungen in zwei grundlegenden Stoffwechseltypen (Bau- und Betriebsstoffwechsel) von Schimmelpilz. Als Versuchsobjekt kam *Aspergillus oryzae* zur Anwendung, und zur Erprobung gelangten 123 C-Verbindungen. Bei der Deckenkultur wurden davon 51 sowohl zur Atmung wie zum Wachstum verwertet, während bei 8 Verbindungen nur Atmung, nicht aber positives Pilzwachstum beobachtet wurde. Von den übrigen 64 Verbindungen waren 17 von keiner Wirkung auf den Pilz, während 47 nicht nur Hemmung der Restatmung sondern auch mehr oder minder deutliche Herabsetzung des Anfangspilzgewichtes herbeigeführt haben. Bei der Sporenkultur gestatteten 47 Verbindungen mehr oder weniger positives Wachstum, 7 aber nur unbedeutendes Auskeimen oder Heranwachsen der Pilzhypphen, und die übrigen 69 Verbindungen zeigten gar keinen Nährwert.

Im allgemeinen zeigten sich Kohlehydrate und mehrwertige Alkohole als die beste C-Quelle für den untersuchten Pilz. Aromatische Alkohole und einwertige Paraffinalkohole sind überhaupt ganz untauglich, zwar aber mit einer Ausnahme von Äthylalkohol, der sowohl für Atmung als auch für Wachstum gut verwertbar ist. Unter den organischen Säuren stellen im grossen und ganzen Paraffindicarbonsäuren, Oxy-carbonsäuren, und Ketocarbonsäuren besser verwertbare C-Quellen dar als Paraffinmonocarbonsäuren und Olefincarbonsäuren. Unter den organischen Säuren mit zyklischer Struktur sind verschiedene Phenolcarbonsäuren, Chinasäure und Kojisäure mehr oder minder gute C-Quellen. Ganz untauglich sind aber verschiedene Aldehyde, Ketone und Äther.

Der Kernpunkt dieser Arbeit liegt auf der Beantwortung der Frage, ob für die Ausnutzbarkeit und Nichtausnutzbarkeit der C-Quelle irgend ein entscheidendes Moment vorhanden sei oder nicht. Der Verfasser hat darauf aufmerksam gemacht,



dass die angreifbaren C-Quellen fast ausnahmslos irgend eine von folgenden Atomgruppen, die er „Hauptradikalen“ nannte, an einem Ende der Kette oder im Ring enthalten:



Die Verbindungen, bei denen die Hauptradikale fehlen, sind immer unangreifbar. Jedoch stellt das Vorhandensein der einen von diesen Atomgruppen nicht den einzigen bedingenden Faktor für die Ausnutzbarkeit der C-Quellen dar, und zwar müssen bei verwertbaren C-Quellen die in Frage kommenden 2-C-atomigen Radikale wenigstens noch einmal in „Restradikalen“ vertreten sein. Gestützt auf mehrere experimentelle Tatsachen hat der Verfasser die Annahme vertreten, dass die Verbrennung der C-Quellen, wenigstens bei ihrem ersten Angriff, immer mit der oxydoreduktiven Abspaltung des Hauptradikals einsetze.

Beiläufig wurden auch die Versuchsergebnisse über anaerobe Gärung und die Kojisäurebildung bei Zugabe von verschiedenen C-Quellen angegeben. Die anaerobe Gärung von *Asp. oryzae* scheint im wesentlichen identisch mit der alkoholischen Gärung der Hefe zu sein, indem bei allen Nichtzuckerstoffen (mit der Ausnahme von Brenztraubensäure) gar keine Gärung stattfand. Unter Hinweis auf mehrere Tatsachen hat der Verfasser gegen die sogen. Theorie des genetischen Zusammenhanges Stellung genommen.

Die theoretische Besprechung dieser Abhandlung wurde mit der wichtigen Anmerkung geschlossen, dass für die Verwirklichung der synthetischen Vorgängen (Wachstum) in aeroben Zellen immer die Zuführung einer gewissen Menge der freien Energie unbedingt vonnöten ist, die nur durch  $\text{O}_2$ -Atmung geliefert werden muss, und zwar durch die Energie der anaeroben Atmung oder anderweitigen Oxydoreduktion nicht ersetzt werden kann.

Verf.

**187. Zur Physiologie der Essigsäuregärung. II. (Über die Einwirkung des Kaliumcyanids und des Acetons und über die Dismutation.)** Kiyoshi TANAKA. (*Acta Phytochimica*, 5, 1932, 239-266).

An die früher veröffentlichte Arbeit von TAMIYA und TANAKA anschliessend hat der Verfasser in dieser Mitteilung die Resultat seiner Versuche über die Einwirkung Kaliumcyanids und des Acetons auf die Essigsäuregärung von *Bac. Pasteurianum*



nebst einer Bemerkung über die atmungsphysiologischen Bedeutung der Dismutation bei Essigsäuregärung näher dargelegt. Es ergab sich nämlich zunächst, dass bei der KCN-Zugabe zur Bakteriensuspension oder bei den Versuchen mit Acetonbakterien sowohl die Chinon- als auch die Methylenblau-Gärung stets wesentlich unbeschädigt erfolgen, während dabei die  $O_2$ -Gärung stark unterdrückt wird. Gibt man also hierbei zu, dass das dehydrierende Enzym selbst von KCN oder Aceton im wesentlichen nicht beschädigt werde, so folgt natürlich, dass bei der  $O_2$ -Gärung ein anderer funktions-tüchtiger Faktor als dehydrierendes (oxydierendes) Enzym durch die in Frage kommenden chemischen Agenzien beschädigt werde. Dieser Faktor, welcher nur bei der  $O_2$ -Gärung ins Spiel kommt, ist nach der Theorie von SHIBATA und TAMIYA nichts anderes als das Cytochrom.

Acetonbakterien besitzen nach dem Verfasser die Fähigkeit, Aldehyd zu dismutieren. Diese Erscheinung hat der Verfasser so gedeutet, dass der Aldehyd bei demjenigen Dehydrierungsvorgang, welcher durch ein und dasselbe Enzym wie bei Mb-, Chinon- oder  $O_2$ -Gärung in Gang gesetzt wird, als H-Acceptor fungiert. Sehr beachtenswert ist hierbei die festgestellte Tatsache, dass sich die Mb- und Chinon-Gärung und die Dismutation gegen verschiedene äussere Faktoren wesentlich gleich verhalten, und das nur die  $O_2$ -Gärung in dieser Hinsicht eine Sonderstellung einnimmt. Nach alledem treten die Ergebnisse von dieser interessanten Arbeit ganz beweisend der Theorie von SHIBATA und TAMIYA über die Cytochromfunktion hinzu. TAMIYA.

**188. *Phytophthora blight of peony.*** (Japanese with English résumé). Heiz-TASUGI and Masatake KUMAZAWA. (Jour. Imp. Agric. Expt. Sta. Tôkyô **2**, 1932, 75-96, 3 pls. and 3 text-figs.).

*Phytophthora paeoniae* causes the blight of *Paeonia albiflora* much cultivated in Japan, which is very similar to the *Botrytis* disease. The mycelia are intercellular and produce spherical haustoria penetrating into the host-cells. The culture on various media was done, of which bean agar was found best for the fungus development. On culture media conidia, oospores and chlamydospores are easily developed. 23°C, pH 5,5-6,4, and the culture media containing 5% glucose were found best for the fungal development. The inoculation experiments have shown that *Solanum tuberosum*, *Capsicum annum*, *Dolichos Lablab* and *Phaseolus vulgaris* are quite immune towards this fungus.

**189. Tetraploide Bastarde von *Brassica chinensis* und *Raphanus sativus*.** (Japanisch). Yasukusa TERASAWA. (Japan. Jour. Gen. **7**, 1932, 183-185).

Bei der Kreuzung zwischen *Brassica chinensis* und *Raphanus sativus* gelang es dem Verf. die fruchtbaren Nachkommen zu bekommen, wenn die letztere Art als Vater verwendet wurde, was gerade im Gegensatz zu dem von KARPETSCHENKO hergestellten *Raphanobrassica* Bastard steht. In  $F_4$ -Generation dieser Kreuzung hat der Verf. eine kleine Anzahl von Nachkommen mit 38 diploiden Chromosomen (=Summe der diploiden Chromosomenzahl beider Eltern) bekommen, die fruchtbar sind und sich in  $F_5$  konstant erwiesen haben.

**190. The black rot of rice-grains caused by *Pseudomonas Itoana*, n. sp.** (With Japanese résumé). Yoshihiko TOCHINAI. (Ann. Phytopathol. Soc. Japan **2**, 1932, 453-457).

In most cases the apical part of rice-grain is affected by the rot, and becomes black. The rot is due to the action of *Pseudomonas Itoana* n. sp. Its cultural and physiological characters were studied and are described in this paper. The growth takes place between 26-30°C, the optimum being 29° and the maximum 40°. The production of indol and the reduction of nitrate were proven. No ammonia was detected.

**191. *Sporotrichum Narcissi* sp. nov. parasitic on *Narcissus* bulbs.** (With Japanese résumé). Yoshihiko TOCHINAI and Shoichi SHIMADA. (Trans. Sapporo Nat. Hist. Soc. **11**, 1930, 121-128).

On diseased young plants of *Narcissus pseudo-Narcissus* the authors have found two species of *Sporotrichum*, viz. *S. radiculolum* ZIMMERMANN and *S. Narcissi* sp. nov. Though the former was considered by ZIMMERMANN to be a mere saprophyte, the authors could prove by actual inoculation experiments that this as well as the other species are really wound parasites. (Cf. the next No.).

**192. Further notes on *Narcissus* bulb-rot.** (With Japanese résumé). Yoshihiko TOCHINAI and Shoichi SHIMADA. (Trans. Sapporo Nat. Hist. Soc. **12**, 1931, 23-26).

Further examination of the fungi which were under discussion in the preceding No. led the authors to the conclusion that the names *Sporotrichum radicola* ZIMMERMANN and *S. Narcissi* should be changed into *Trichoderma Narcissi* and *Pachybasium bulbicolum* respectively, both of which are new species.

**193. Studies on the physiological specialization in *Piricularia Oryzae* BR. et Cov.** (With Japan. résumé). Yoshihiko TOCHINAI and Mitsutaro SHIMAMURA. (Ann. Phytopathol. Soc. Japan. **2**, 1932, 414-441, 2 pls. and 1 text-fig.).

*Piricularia Oryzae* collected from various localities was cultivated on four kinds of culture media, viz. apricot juice agar, onion decoction agar, rice plant decoction agar and pepton-sucrose synthetic agar. The authors could distinguish in each of these culture media various types of *Piricularia* differing by their respective cultural characteristics. Basing upon such data the authors distinguish 9 physiological forms of *Piricularia Oryzae*. Thus, for instance, on rice-plant decoction agar Forms I-IV grow better at 25°C than at 28°C, while the reverse is the case with Forms VI-IX. Again, the length measurement of conidia of these forms cultured on steamed rice-straw has shown that those of Forms I, II, IV, V and IX are somewhat larger than those of Forms III, VI, VII and VIII. It is also to be added that the apex of conidia is more attenuated in the former group of forms than in the latter.

**194. Studies on the effects of fat-soluble vitamin upon the growth of some parasitic fungi.** Yoshihiko TOCHINAI and Mutsuo TERUI. (Jour. Fac. Agric. Hokkaido Univ. **32**, 1932, 71-107, 2 pls. and 16 text-figs.).

According to the results of the investigations already published the vitamin A is to be considered as a growth-promoting principle for animals and yeast-fungi. The authors made experiments to determine the effect of that vitamin on four kinds of fungi, 1. *Helminthosporium turcicum*, 2. *Ophiobolus Miyabeanus*, 3. *Gibberella Fuzikuroi* and 4. *Glomerella Lindemuthiana*. Riken vitamin A and biosterin were used for the present experiments, both of which are the solution of vitamin extracted from cod-liver oil in olive oil. First of all, it was ascertained that high temperature necessary for the sterilization does not impair at all the effect of Riken vitamin A. The parallel cultures of fungi in media containing olive oil with or without the addition of Riken vitamin or biosterin were performed. The following effects were observed. Nos. 1 and 3 of the above mentioned fungi are quite indifferent towards olive oil, while it promotes more or less intensely the growth of Nos. 2 and 4. The addition of Riken vitamin or biosterin to the culture media promotes the growth of Nos. 2 and 3, when its % is low, but retards it, when its % is high. The growth of Nos. 1 and 4 is always retarded by its addition, even though its % is low.

**195. Befruchtung und Kernteilung bei *Coccophora Langsdorffii* (TURN.) GREV.** Kôgorô TOMITA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. **7**, 1932, 42-47, 2 Taf. und 1 Textabb.).

Der Verf. hat eine künstliche Besamung bei *Coccophora Langsdorffii*, einer im Japanischen Meere einheimischen Fucacee ausgeführt und das nachherige zytologische Verhalten untersucht. Danach 1/2-1 Stunde nach dem Eintreten des Spermatozoids in die Eizelle kommt der Spermakern allmählich in der Nähe des Eikernes und weist ein deutliches Nukleolus und das Chromatingerüst auf. 3 Stunden nach der Besamung kommt der Spermakern in Kontakt mit dem Eikern und verschmilzt bald mit ihm. Der Spermakern desorganisiert sich bald, wonach man in der Eizelle zwei Nukleolen unterscheidet, welche aus dem Ei- und dem Spermakern herkommen sollen. Bald folgt die Kernteilung, wobei keine Zentrosomen nachweisbar sind. Die Chromosomenzahl beträgt 64.

**196. On the difference between *Brassica campestris* L. and *B. Napus* L. in regard to fertility and natural crossing.** (Japanese with English résumé). NAGAHARU U and TUTUMI NAGAMATU. (Jour. Imp. Agric. Exp. Sta. Tôkyô **2**, 1932, 113-128, 1 pl.).

The grade of fertility, as measured by the number of ripe seeds produced in some varieties of *Brassica campestris* and *B. Napus* under natural, net- (i.e. under the cover of cloth-net with honey bees), self- and cross-pollination was studied. The *Napus* varieties are quite indifferent towards the mode of pollination and their fertility is 75% in average. On the contrary, in *campestris* varieties the fertility from natural or cross pollination is 70% on the average, while that under net- and that under self-pollination are 43 and 29% respectively. In a pure strain of *campestris*-variety the frequency of natural crossing was found to be as high as 76%, while in a special type of the *Napus*-variety it was nearly 9%.

As regards the natural crossing between *campestris* and *Napus* it was observed that in the former no natural hybrids were found, while in the latter their 4% was detected.



**197. Contributions to the cytology of fungi. Chromosome number in Autobasidiomycetes.** K. WAKAYAMA. (Cytologia **3**, 1932, 260-284, 133 text-figs.).

The fungi studied by the author include 17 Agaricaceae, 7 Polyporaceae, 3 Lycoperdaceae, and 1 Thelephoraceae. In all fungi studied the nuclear phenomena in the basidium take place in usual manner. Thus the mitotic spindle is of intranuclear origin, and a centrosome is visible at each pole. Presynaptic stages, synaptic knot, diakinesis, etc. are always observable. The second division is equational, and in some forms there occurs a third division which gives rise to eight nuclei. The chromosome number was studied in 34 species in all, which is either 6, 4 or 2.

**198. Über die Bedeutung der Nährbakterien für die Entwicklung der Myxomyceten-Plasmodien.** Atsushi WATANABE. (Bot. Mag. Tôkyô **46**, 1932, 247-255, 1 Textfig.).

Die Experimente wurden ausgeführt, um es kennen zu lernen, welche Bakterien als Nahrungsmittel des Myxomyceten-Plasmodiums am besten geeignet sind und welche Myxomyceten mit Bakterien die beste Entwicklung zeigen. Dafür wurden 17 Myxomyceten- und 16 Bakterienarten benutzt. Unter allen diesen wurde es erwiesen, dass verschiedene Myxomyceten die grösste Vorliebe für *Bacterium Zopfii* zeigen und *Didymium nigripes* var. *xanthopus* mit Bakterien als Nahrung seine beste Entwicklung genießt.

**199. Physiological studies in the pine-apple roots.** (Japanese with English résumé). Shôichi WATANABE. (Jour. Soc. Trop. Agric. **3**, 1931, 365-376, 6 text-figs.).

The author's experiments on the growth of pine-apple roots, as influenced by soil temperature, etc. have led him to the following main conclusions:

The elongation of the main roots takes place best in loam and humus and worst in sand, while the amount of roots is best in sand and worst in humus. Fertilizers do not show remarkable effects for the elongation as well as the differentiation of roots. The lack of Ca-ion checks the elongation of the main roots and the branching of root-hairs. The presence of  $\text{PO}_4$ -ion weakens the elongation of the main root, and favours the increase of the number as well as the development of the branch roots. The presence of  $\text{NO}_3$ -ion favours the elongation of lateral and minute roots. The lack of K-ion has no influence on the development of the root system.

The proper hydrogen-ion concentration of the nutrient solution over or under 4.5-4.7 acts unfavourably upon the root development.

The elongation of the main root and the rise of temperature go parallel. Within the extent 20-29°C a slight increase as well as a slight decrease of temperature cause a considerable rise and fall of the root elongation respectively.

**200. On the sexual reproduction of *Prasiola japonica*,** YATABE. Yoshitada YABE. (Sc. Rpts. Tokyo Bunrika Daigaku Sect. B, **1**, 1932, 39-40, 1 pl.).

In *Prasiola japonica* all vegetative cells change either into macro- or microgamet-angia, which are found on one and the same frond. The division of each cell into 16 gives rise to the macrogametes, and that into 64 to the microgametes. Both kinds of



gametes are oval and biciliate, the former being twice as large as the latter. The copulation of one macro- and one microgamete produces a zygote which germinates after a long period of rest.

**201. Notes on some Japanese algae III.** Yukio YAMADA. (Jour. Fac. Sc., Hokkaido Imp. Univ., Ser., V, **1**, 1932, 109-123, 4 pls. and 5 text-figs.).

Among the algae enumerated by the author the following are new species and described: *Vaucheria constricta*, *Acrothrix pedata*, *Rhodochorton affine*, *Plenosporium pusillum*.

**202. Über elektrische Potentialveränderungen an periodisch sich bewegendem Primärblättern von *Canavalia ensiformis* DC.** (Mit japan. Zfg.). Yasuke YAMAGUTI. (Bot. Mag. Tôkyô **46**, 1932, 216-222, 8 Textabb.; 368).

Die Messung der elektrischen Potentialveränderung bei der tagsperiodischen Bewegung der primären Blätter von *Canavalia ensiformis* wurde vom Verf. ausgeführt, und zwar an den dem natürlichen Tagswechsel unterworfenen Pflanzen während der Dauer von mehr als 24 Stunden. Dabei wurde es festgestellt, dass das elektrische Potential des Blattstiels gegen den Stengel oder dasselbe der Blattspreite (Hauptnerv) gegen den Stengel sowie den Blattstiel am Tage hoch und an der Nacht niedrig ist.

In einer konstant elektrisch beleuchteten Dunkelkammer bleibt alsbald die Blattbewegung aus, doch da nach vier Wochen in unerwarteter Weise die Blätter eine kleine Bewegung zu machen begannen, studierte der Verf. an den Blättern von in solcher Weise konstantbeleuchteten Pflanzen die Potentialveränderung, und es wurde dabei festgestellt, dass die Beziehung zwischen der Blattbewegung und der Potentialveränderung gleich wie beim obengenannten ist, somit ist es klar, dass die Potentialveränderung keineswegs eine durch die Licht- oder Temperaturveränderung verursachte Erscheinung ist.

**203. Über die Färbbarkeit der fixierten Zellstrukturen.** Gihei YAMAHA. (Sc. Rpts. Tokyo Bunrika Daigaku Sec. B, **1**, 1932, 1-21).

Einige in diesem Aufsätze enthaltene Einzelheiten sind wie folgt.

Die Färbbarkeit der Protoplasmastrukturen durch entweder Karyotinfarbstoffe oder mit SCHUMACHERS Lipoidfarben wird bei den fixierten Materialien gar nicht beeinflusst. Sublimat, Alkohol und Formol begünstigen die Färbbarkeit, während Trichloressigsäure und Salpetersäure sie vermindern. Reine Kernfärbung erfolgt oftmals durch die Fixierung mittels Essigsäure und Alkohol. Die Karyotinfärbbarkeit ist hauptsächlich dem die Nukleinsäure fixierenden Vermögen des benutzten Fixiermittels zu verdanken, während bei der Zytoplasmafärbung ausser den chemischen Faktoren die Dispersität der fixierten Protoplasmastruktur in Betracht gezogen werden muss. Der pH-Wert des Fixiermittels hat mit der Färbbarkeit der Zellstrukturen nichts zu tun.

Für die weitere Aufgaben s. das Original.

**204. Über die Ionenwirkung auf die Chromosomen der Pollenmutterzellen von *Tradescantia reflexa* L.** Gihei YAMAHA und Tomoyuki ISHII. (Cytologia 3, 1932, 333-33).

Die Verf. haben bei dem Färbungsversuch der Pollenmutterzellen von *Tradescantia reflexa* mit Eosinlösung es beobachtet, dass die Chromosomen in verdünnter Phosphorsäure von etwa 3,5 pH niemals gefärbt sind, während sie in genügend hochkonzentrierten Phosphatgemischen bei irgend einem pH-Wert sich färben lassen. Diese Beobachtung widerspricht scheinbar der früher von KUWADA und SAKAMURA festgestellten Tatsache, dass die Chromosomen der Pollenmutterzellen sichtbar gemacht werden können, soweit als die obere pH-Grenze bei 5,2-5,4 liegt. Um die obige Frage aufzuklären, wurden von der Verf. eine Reihe von speziellen Experimenten ausgeführt. Die daraus von ihnen gezogenen Schlüsse sind wie folgt: 1. in verschiedenen Pufferlösungen sind nicht nur H-Ionen, sondern auch andere Ionen auf die Karyotinfällung wirksam; 2. wenn in genügend hochkonzentrierten Pufferlösungen die Chromosomen bei irgend einem pH-Wert gefärbt werden, gibt es in verdünnten eine bestimmte pH-Grenzen für ihre Färbbarkeit welche nach der Konzentration der Lösungen variabel ist; 3. je verdünnter die letzteren sind, um so näher liegt diese pH-Grenze deren von freien Säuren (3,0-4,0).

**205. Über den Nachweis von Oxydasen bei holzzersetzenden Pilzen.** (Japanisch). Kichinosuke YAMAMOTO. (Forsch. a. d. Geb. d. Pflanzenkrank. 1, 1932, 168-174, 1 pl.).

Die Klassifizierung von holzzersetzenden Pilzen nach BAVENDAMM zu den Ligninzersetzern und Zellulosespezialisten, je nachdem sie die Oxydationszone bilden oder nicht, wurde an 6 Arten vorgenommen. Es wurde dabei festgestellt, dass *Fomes applanatus*, *Polystictus pargamenus*, und *Polyporus orientalis* zu der ersten Klasse, und *Fomes pinicola*, *Polyporus Schweinitzii* zu der zweiten gehören. Bei den Versuchen gaben beide 0.25% Gerbstoff und Gallussäure gute Resultate, und besonders die letztere.

**206. Synopsis specierum generis *Balanophora* in Japonia et Formosa sponte crescentium.** Yoshimatsu YAMAMOTO. (Ann. Rpt. Taihoku Bot. Gard. 1, 1931, 93-97).

14 *Balanophora*-arten sind enumeriert, von denen die folgenden neu und beschrieben sind: *B. Kudoi* und *Oshimai*.

**207. Observationes ad floram formosanam II.** (Mit japan. Zfg.). Yoshimatsu YAMAMOTO. (Jour. Soc. Trop. Agric., Taihoku Imp. Univ., Formosa 4, 1932, 49-55, 3 Textabb.).

Die folgenden sind neu beschrieben: *Lithocarpus impressivena* var. *falcato-caudata* var. nov., *L. brevicaudata* var. *pinnativena*, var. nov., *Boehmeria nivea* var. *viridula*, var. nov., *Oxalis Termini* sp. nov.

**208. Supplementam plantarum formosanarum V.** Yoshimatsu YAMAMOTO. Publ. by Dpt. Forestry, Gov. Res. Inst., Taihoku, Formosa 1932, 47 pp., 3 pls. and 8 text-figs.).

Among others *Amentotaxis ergotaenia* (HANCE) PILGER, *Carpinus Sexii* sp. nov., *Aconitum Bartlettii* YAMAMOTO, *Clematis Bartlettii*, *Illicium daibuense*, *Corylopsis Matsudai*, *Crawfurdia cordifolia*, *Euphrasia nankotaizanensis*, *Plantago sawadai*, *Valeriana nokoizanensis* are described in detail, generally accompanied by illustrations.

**209. On the special substance that inhibits self-fertilization. Physiological consideration on its nature based on the results of the experiments on the fertility of *Petunia violacea*.** (Japanese). Sadao YASUDA. (Japan. Jour. Gen. **7**, 1932, 188-193, 1 fig., also in English with Japan. résumé in Bot. Mag. Tôkyô **46**, 1932, 225-231, 369-370).

The author's results which were already published partly in other places, are briefly as follows,

The special substance which inhibits the self-fertilization in *Petunia violacea* accelerates the cross-fertilization. It is secreted in the ovary and goes upwards in the pistil. It is especially abundant in the upper part of placenta. Its activity declines in weak or old plants and heightens by cultivation under high temperature. This substance is soluble in water, can pass through gelatine and retains its power even in the dry powder of pistil as well as in the dry matter of its water extract.

**210. Revegetation of volcano Komagatake after the great eruption in 1929.** Yoshiji YOSHII. (Bot. Mag. Tôkyô **46**, 1932, 208-215, 1 pl.).

The regeneration of plants after the eruption of Mt. Komagatake near Hakodate in Southern Hokkaidô was studied by the author, who could distinguish its three different processes. Firstly, during the eruption pumice flows expelled out from the crater naturally damaged the long area covered with the vegetation, but here and there remained small patches—or islands—which are quite intact, and plants growing there, and especially in their interior part, remain alive. Such plants will naturally contribute greatly to the revegetation. Secondly, even in the pumice-field, the deposition of pumice was slight in many places, so that plants growing there are not at all or very slightly damaged. Especially some herbaceous plants, of which the subterranean parts remain uninjured, will largely contribute to the revegetation. Thirdly, in places which were covered by ash from the beginning or became such by the washing away of pumice the ground will become easily accessible to emigrants.

**211. Mikrochemischer Nachweis von Aluminium und sein Vorkommen im Pflanzenreiche.** Yoshiji YOSHII und Tadao JIMBO. (Sc. Rpts, Tôhoku Imp. Univ. 4th Ser., **7**, 1932. 65-77).

Mittels der Anwendung von Alizarin S, welches zum mikrochemischen Nachweis von Aluminium im pflanzlichen Gewebe geeignet ist, studierten die Verf. 647 Phanerogamen und 134 Kryptogamen bezüglich ihrem Aluminiuminhalt. Alle oder fast alle Pflanzen aus Symplococaceen, Diapensiaceen, Theaceen, Cyatheaceen, Gleicheniaceen und Lycopodiaceen enthalten dieses Metall in den Blättern angehäuft. Weiter konnten die Verf. eine beträchtliche Menge dieses Metalles bei vielen Phanerogamenarten, einigen Filicineenarten, je einer Art aus Lycopodiaceen, Lebermoosen und Moosen nachweisen.

**212. Über die Keimung des Pollens bei den *Linum*-arten.** (Japanisch). Keizirô YOSIDA. (Proc. Crop Sc. Soc. Japan **4**, 1932, 92-99).

Wegen der schwachen Widerstandsfähigkeit des *Linum*-Pollens gegen Wasser, ist es empfehlenswert, für seine Keimungsversuche als Nährboden den mit feuchtem Gummi arabicum angestrichenen Objektträger zu benutzen. Die Keimung des Pollens geschieht am besten bei solchem, welcher aus den Blüten zur Zeit des Petalenabfallens herausgenommen wurde. Trockener Pollen, welcher während 4 Stunden 30°C ausgesetzt ist, wird keimungsunfähig, während solcher, welcher 3°C ausgesetzt wird, vollständig keimungsfähig ist. Das Optimum für die Keimung beträgt 10-20°C. Unter den vom Verf. untersuchten Arten wurde die stärkste Keimfähigkeit bei *Linum campanulata* sowie *flavum* und die schwächste bei *L. usitatissimum* beobachtet.

**213. Studies in the cytology of Pteridophyta. I. On the spermatozoid of *Pteris cretica* L. var. *albolineata* HK.** Akira YUASA. (Bot. Mag. Tôkyô **46**, 1932, 4-12, 4 figs.).

The spiral body of the spermatozoid of *Pteris cretica* var. *albolineata* contains 2,5-3,5 coils, and is generally right-handed. Between the nucleus and the border-brim is the broad cilia-bearing band which remains unstained by various reagents. The number of cilia ranges from 30~65. The border-brim is considered to be a specially organized region, as shown by its staining reaction as well as its appearance during the spermatogenesis and afterwards.

The dehiscence of an antheridium is due to the combined action of the swelling of its wall-cells and that of spermatogenous mass. The direction of the spermatozoid rotation is just contrary to that of the body-spiral, and the velocity of movement is 0,75-1 mm per sec. in active state.



## Abstracts Nos. 214–333

(Referring to the principal papers in Botany and allied subjects which have appeared in Japan during July–December 1932).

**214. Conspectus caricum japonicarum. A general view of Japanese carices including those from Saghalien, the Kuriles, Hokkaido, Honshiu, Shikoku, Kiu-shiu and the Riukius, with special reference to utricles in female flowers.** Shigeo AKIYAMA. (Jour. Fac. Sc., Hokkaido Imp. Univ. Ser. V (Bot.) **2**, 1932, 1–266, 2 pls. and 172 text-figs.).

After an introduction (pp. 1–4) which is chiefly concerned with the history of the study of Japanese *Carex* species by various authors, foreign as well as native, a key for subgenera, sections, subsections and species is given (pp. 5–47). The greatest part of the paper is occupied by the enumeration of species, 287 in all, in many of which we find the description of utricles with illustrations (pp. 48–238). The habit of the two new species, *Carex pseudo-sadoensis* and *C. Ogawai* is illustrated in two plates. An extensive table showing the geographical distribution of species, varieties and forms of *Carex* within and without Japan is appended (pp. 237–256). The paper ends with the index of species, etc. included in it (pp. 251–266).

**215. Chromosome studies of  $F_1$  *Aegilops speltoides*  $\times$  *Triticum monococcum*.** Yoshiwo CHIZAKI. (Bull. Utsunomiya Agric. Coll. **2**, 1932, 43–47, 12 text-figs.).

The cross, *Aegilops speltoides* var. *ligustica*  $\times$  *Triticum monococcum* ( $n = 7$  in both parents) has given a single  $F_1$  plant which is generally similar to the mother. In the meiosis of the pollen mother-cells, of which the diploid chromosome number is 14, the chromosomes are mostly the bivalents with few univalents. The trivalents and the tripartite chromosome consisting of three connected univalents were rarely seen. The partners of each bivalent are distributed as usual, while the univalents go to either pole by chance. The tripolar spindles were often seen. The tetrad formation goes on pretty regularly.

**216. Über die Chemotaxis der Myxomyceten-Plasmodien.** Yoshikadzu EMOTO. (Proc. Imp. Acad. **8**, 1932, 460–463, 2 Textabb.).

Die Plasmodien von *Physarum viridis* und *P. rigidum*, welche an den Fruchtkörper einiger Hutpilze (*Polystictus*, *Polyporus*) kultiviert sind, wurden auf Agarplatte gelegt, und kleine Stücke von Filtrierpapier, welche in die Versuchslösung getaucht sind, sind neben den Plasmodien gelegt, um ihr chemotaktische Verhalten zu studieren. Die Resultate sind im allgemeinen wie folgt. Bei konzentrierten organischen und anorganischen Säurelösungen ist die Reaktion negativ und bei verdünnten positiv, und zwar bei den organischen sogar bei höherer Konzentration als bei den anorganischen. Bei alkalischen Lösungen ( $pH > 9,8$ ) ist die Reaktion immer negativ. Bei sauren Lösungen der Salze ist sie immer positiv und bei alkalischen immer negativ.

bei Zucker-, Fleischextrakt- und Peptonlösungen positiv, bei Polysacchariden und Alkoholen nicht.

**217. Über zwei noch nicht in Japan bekannte Myxomyceten.** (Japanisch m. deuts. Zfg.). Yoshikadzu EMOTO. (Bot. Mag. Tôkyô **46**, 1932, 593-596, 4 Textabb.).

*Barbeyella minutissima* MEYL. und *Licea minima* FR. wurden neuerdings in Japan entdeckt. Bemerkungen dazu hinzugefügt.

**218. The host plants of *Hypochnus centrifugus* (LÉV.) TUL. ever recorded in Japan.** Shigeru ENDÔ. (Trans. Tottori Soc. Agric. Sc. **3**, 1931, 254-270, 4 pls.).

159 species enumerated. They belong to 47 families of Angiosperms, 1 of Gymnosperms, 2 of Ferns, 2 of Hepaticae and 1 of Musci.

**219. Studies on the antagonism of microorganisms II. Growth of *Hypochnus Sasakii* SHIRAI as influenced by the antagonistic action of other microorganisms.** (With Japanese résumé). Sigeru ENDÔ. (Bull. Miyazaki Coll. Agric. & Forest. **4**, 1932, 133-158).

The author has made a series of experiments on the antagonistic action of a number of bacteria and fungi against *Hypochnus Sasakii*, either in soil or culture media. Of bacteria used for the experiment 26 species were observed to retard the growth of *Hypochnus*, while the remaining 3 were quite indifferent. A great number of *Aspergillus* species were observed to cover the colony of *Hypochnus*, and retard its growth. *Penicillium citrinum* is also antagonistic, but less so, and between it and *Hypochnus* in culture a sterile region was formed, where the growth of both stops. A certain number of *Aspergillus* and *Penicillium* are quite indifferent towards the growth of *Hypochnus*. A certain number of bacteria cover the sclerotia and mycelia of the latter, and induce their death, both in soil and culture media.

**220. Studies on the antagonistic action of microorganisms III. Pathogenicity of *Hypochnus centrifugus* TUL. and *Hypochnus Sasakii* SHIRAI in the presence of the other microorganisms.** (With Japanese résumé). Sigeru ENDÔ. (Bull. Miyazaki Coll. Agric. & Forest **4**, 1932, 159-184).

A certain species of *Bacillus* and *Aspergillus* weaken the pathogenicity of *Hypochnus centrifugus* and *H. Sasakii* in soil, while some others are even so antagonistic that they prevent wholly the appearance of the disease symptoms due to *Hypochnus*.

**221. Influence of carbohydrates and organic nitrogen compounds on the antagonistic action of microorganisms.** (Japanese). Sigeru ENDÔ. (Ann. Phytopath. Soc. Japan **2**, 1932, 2 pp.)

The intensity of antagonistic action of various bacteria and fungi on the growth of *Hypochnus* is variable in different culture media. To cite a few examples, the antagonistic action of *Aspergillus niger* is greatest, when as nitrogen source tyrosin, ammonium citrate, alanin, pepton, etc. are used, and less, when legumin, asparagin,

egg white, salicin, uric acid, fibrin, etc. are in use. Again it is greatest, when as the carbohydrate lactose, corn starch, dextrose, glycerin, and less, when galactose, glucose, glycogen, inulin, maltose, levulose, raffinose, saccharose, mannose are used.

**222. Cytological studies in *Hypochnus Sasakii* SHIRAI, causing a sclerotic disease of rice plant.** (Japanese with English résumé). Hiroshi FUKANO. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **5**, 1932, 117-136, 4 pls.).

Each cell composing the mycelium contains mostly 6-10 nuclei. Their division is observable in the apical cells of the hypha. When it will take place, all nuclei of each cell assemble and divide simultaneously, the nuclear figure being always parallel to the direction of the hyphal cell. After the formation of daughter nuclei at the two opposite poles a septum is formed between the two series of nuclei, and as it will be easily understood, the number of the nuclei in the cells derived from the same hypha is generally the same. The cytological behaviour in the basidium and the basidiospore is normal. The basidiospore is uninucleate at first and becomes multinucleate afterwards.

**223. Hygronastic curling and uncurling movement of the leaves of *Rhododendron micranthum* TURCZ. with respect to temperature and resistance to cold.** Yasona FUKUDA. (Japan. Jour. Bot. **6**, 1932, 191-224, 14 text-figs.).

**224. On the intracellular bodies associated with the dwarf disease of rice plant.** (With Japanese résumé). Teikichi FUKUSHI. (Trans. Sapporo Nat. Hist. Soc. **12**, 1931, 35-41, 5 text-figs.).

The author has invariably seen in the chlorotic tissue of the leaf of rice plant affected with dwarf disease certain intracellular bodies which are homogeneous, vacuolate and much larger than the nucleus of the host plant. They resemble intracellular bodies seen in certain virus diseases of plants and animals.

**225. A contribution to our knowledge of virus diseases of plants in Japan.** (With Japanese résumé). Teikichi FUKUSHI. (Trans. Sapporo Nat. Hist. Soc. **12**, 1932, 130-141).

The paper is a review of virus diseases of plants hitherto seen in Japan. The virus disease causes mostly mosaic disease, otherwise leaf roll, yellows, dwarf and stripe disease. 71 species of plants belonging to 5 genera and 15 families are known in Japan to be affected by the virus.

**226. Comparison of chromosome types in *Disporum*.** Nobumi HASEGAWA. (Cytologia **3**, 1932, 350-358, 19 figs.).

*Disporum pullum*, *smilacinum*, *smilacinum* var. *ramosum* and a form of *D. sessile* possess 8 and 16 chromosomes in haploid and diploid phase respectively. The author has made the classification of these chromosomes, basing on their length, the relative position of constrictions and the presence or absence of satellites. For the comparison of the chromosome types,



$$\frac{\text{whole length or that of arm formed by the constriction of each chromosome}}{\text{total sum of lengths of all chromosomes}} \times 100$$

was taken for the criterion. According to the results of such studies the corresponding chromosomes are similar between *D. smilacinum* and its variety *ramosum*. In each of other species there are 5 types of chromosomes; in some cases the corresponding chromosomes are similar concerning their type, while in other they are different. The size and shape of chromosomes might have occurred during the phylogenetic evolution of the genus.

**227. The behavior of the *Citrus* canker organisms in soil and in water.** (Japanese with English résumé). Iwao HINO. (*Studia Citrologia* **4**, 1931, 167-178, 1 pl.).

Whether or not *Bacterium citri* which causes the *Citrus* canker can pass winter in the soil till the next spring is unknown. The author's inoculation experiments with garden soil and pond water have proved the possibility of the presence of this organism there during several months. There may be a certain antagonistic action of other organisms against it in soil, but it is hardly so intense as to kill it. Nor will the protozoa in soil powerful enough to destroy it wholly. It was found that the comparatively larger alkalinity, less water content and an abundant nutrition were favorable for its existence. From all his observations the author concludes that the overwintering of the canker organism is very possible.

**228. Genus *Miyoshiella* to be included in genus *Chaetosphaeria*.** (With Japanese résumé). Iwao HINO. (*Bull. Miyazaki Coll. Agric. & Forest.* **4**, 187-192).

The diagnosis of the genus *Miyoshiella* (formerly *Miyoshia*) should be modified, owing to the discovery of a new species, but this modification will cause a confusion with the genus *Chaetosphaeria*. The author thinks best to abolish the genus *Miyoshiella*, and to range all species included in it among the genus *Chaetosphaeria*.

**229. Studies on the morphological and physiological characters of *Sclerospora graminicola* on *Setaria italica*.** (Japanese). Eikiti HIRATA and Haruyosi TAKENOUTI. (*Ann. Agric. Exp., Sta., Gov.-Gen. Chosen (Tyôsen)* **6**, 1932, 157-200, 3 pls.).

The mycelium of *Sclerospora graminicola* runs intercellularly in the host tissue, and rarely goes outwards through stomata. Haustoria produced from them enter the host cells. Each conidium produces 2-3 biciliate swarmspores. Oospores, oogonia and antheridia were seen. Each oospore produces one germ-tube. The conidiophores and conidia are constantly produced, so long as the leaf surface is wet and the temperature lies between 12.5-27°C. The germination of conidia and swarmspores takes place when they are immersed in water and get a sufficient supply of air within the temperature limits 12.5-29°C. Light has no influence at all on the germination. The germination of oospores takes place under similar conditions within the temperature 12.5-35°C. They may lie dormant eight months long without dying.

The authors have studied besides the poisonous action of various chemicals against the oospores.



**230. Nuntia ad floram japonicarum XVII-XIX.** (With Japanese résumé). Masaji HONDA. (Bot. Mag. Tôkyô **46**, 1932, 419-422, 437-438, 633-638, 659-661, 675-678, 723-724).

Among the plants enumerated the following are new and described: *Veronica Denkichiana*, *Dimeria Mikii*, *Reynoutria Yabeana*, *Orobanche akiana*, *Cynanchum Kiyohikoanum*, *Fraxinus Tobana*.

**231. Notulae leguminosarum ex Asiae-Orientalis II-III.** (With Japanese résumé). Takahide HOSOKAWA. (Jour. Soc. Trop. Agric. **4**, 1932, 197-202, 484-491).

The following new species are described: *Cassia garambiensis*, *Indigofera ramulosissima*, *I. byobiensis*. Besides some other plants, including new var., new forms, new comb., and new names are described.

**232. Studies on the Hypocreaceae of Japan. I. Podostroma.** (With Japanese résumé). Sanshi IMAI. (Trans. Sapporo Nat. Hist. Soc. **12**, 1932, 114-118, 2 figs.).

5 species of *Podostroma* are enumerated, and the key for their identification is given. *P. giganteum* and *truncatum* are new and described.

**233. On Stropharia caerulescens, a new species of poisonous toadstool.** (With Japanese résumé). Sanshi IMAI. (Trans. Sapporo Nat. Hist. Soc. **12**, 1932, 148-151, 1 fig.).

A new species *Stropharia caerulescens* is described. It is poisonous, and the symptoms of intoxication are described concerning two cases of poisoning.

**234. On the concentration of cell-sap in mulberry leaves.** (Japanese). Yosisato IMAMURA and Moiti HURUYA. (Bull. Seric. and Silk-Ind., Japan **4**, 1932, 142-146).

The cell-sap concentration of mulberry leaves was studied by plasmolytic method, using NaCl solution of various concentrations. It was found that the cells composing different kinds of tissues are also different in this respect. The cell-sap concentration increases successively in the following order, viz. upper epidermal cells of leaf, lower ones, spongy parenchyma cells, and palisade parenchyma cells. The cell-sap concentration is also different in leaves produced at different heights of a branch. It is generally low in the first unfolding leaf, increases gradually in successive leaves, and then descends. During the development of each individual leaf a similar phenomenon is observed: it increases gradually from its beginning and then decreases.

**235. Cytological studies in the genus Lycoris. I. Conjugation of chromosomes in meiosis of Lycoris albiflora, KOIDZ.** (Japanese with English résumé). Sukeo INARIYAMA. (Bot. Mag. Tôkyô **46**, 1932, 426-434, 11 text-figs.).

In the root-tip cells as well as the pollen mother-cells in the late heterotypic prophase of *Lycoris albiflora* there are 12 rod-shaped and 5 V-shaped chromosomes. Each of the latter is constricted at a point a little off its middle point. During the

meiosis the following peculiar behaviour of chromosomes was observed: each of the two arms of every V-shaped chromosome conjugates with a rod-shaped chromosome, and the remaining two rod-shaped ones not concerned in this conjugation form together one bivalent. The author thinks that each arm of every V-shaped chromosome may represent one rod-shaped chromosome, and further that *L. albiflora* may be a natural hybrid formed between two species, *L. sanguinea* with 11 rod-shaped and *L. aurea* with 5 V-shaped chromosomes in haploid stage.

**236. Meiosis in barley.** (Japanese with English résumé). Choyo INOUE. (Proc. Crop Sc. Soc. **4**, 1932, 304-310, 2 pls.).

The meiotic processes in 2- and 6-rowed barleys go on quite normally. Only during the first telophase the nucleolus is formed from the chromatin of the chromosomes, and during the second prophase the spirem forms the chromosomes by receiving chromatin from the nucleolus. The author's conclusion is that the nucleolus contains the material for the chromatin formation.

**237. On the daily fluctuation of the osmotic value in plants II.** Tadao JIMBO. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. **7**, 1932, 499-510).

The experiments were performed in the botanical laboratory in Mt. Hakkôda on leaves of *Polygonum sachalinense*. The osmotic value at incipient plasmolysis, water content, as well as the quantity of sugars and starch were determined before sunrise and afternoon during a number of days. It was found that the osmotic value at incipient plasmolysis was higher and water content smaller in afternoon than in early morning. The author thinks that though the diurnal increase of the osmotic value is generally attributed chiefly to water deficiency, the new formation of osmotically active substances contributes largely to this increase, among which especially sugars might be most prominent.

**238. Botanische Untersuchungen über japanische Fadenpilze, die auf der Menschenhaut parasitieren. II. Mitteilung. *Microsporon japonicum*.** Toyoakira KAMBAYASHI. (Bot. Mag. Tôkyô, **46**, 1932, 751-771, 4 Taf. und 25 Textabb.).

*Microsporon japonicum* ist ein in Ostasien weit verbreiteter Erreger der Trochophyten-Erkrankungen. Ihre Verbreitung in verschiedenen Teilen Japans ist tabellarisch angegeben. Mittelst der Nährbodenkultur kann man davon zwei Typen unterscheiden; ausser dem Unterschied in den morphologischen Eigenschaften zeigt der 2. Typus im jungen Stadium ein ungefähr zweifache Wachstumsgeschwindigkeit als der 1. Die hauptsächlichsten Fortpflanzungsorgane sind die Konidien, wenn auch die Chlamydosporen gebildet sind. In alten Kulturen sind die askusähnlichen Organe produziert: askusähnlich, weil die Sporenzahl klein und doch variabel ist (2, gewöhnlich 4, auch 6-8, höchstens 12). Den Pilz kann man in die Klasse Hemiascineae einreihen.

**239. Influence of the difference of the pollination mode on the fruits, seeds, and the next generation in a pure line of water-melon.** (Japanese). Takesi KANDA. (Rpt. Agric. Exp. Sta. Nara, special No. 1, 1932, 19 pp.).

The experiments were done during five successive years to test, whether the continual self-fertilization of a race of water-melon (Yamatozuikwa in Japanese) in pure line will result in the lowering of its production or even its degeneration. The results of natural pollination, self-pollination, fertilization between two individuals derived from the seeds contained in the same fruit, and cross-pollination were compared. It was found firstly that the fruiting rate is smallest in naturally pollinated plants (e.g. 16.4% against 75% in each case of the three other modes of pollination). Further, it was found that the number of seeds per fruit is greatest in self-pollinated plants. Concerning the physical characters of seeds derived from various modes of pollination there is no visible difference at all. Plants of the generation succeeding self-pollination are in no respect inferior to their parents.

**240. New or noteworthy trees from Micronesia (I, II, III).** (With Japanese résumé). Ryôzô KANEHIRA. (Bot. Mag. Tôkyô **46**, 1932, 449-457, 485-495, 533-536, 669-674, 722-723).

The paper contains the description of woody plants collected by the author during his expedition to Kusai, Ponapei and Truk. With a few exceptions almost all species are new and described.

**241. On triploid tea.** Kôtarô KARASAWA. (Bot. Mag. Tôkyô **46**, 1922, 458-460, 3 text-figs.).

The cytological study of pollen mother-cells of *Thea sinensis* var. *macrophylla* has shown that there are during the meiosis 15 trivalent chromosomes, so that this plant is triploid. This variety is probably an autotriploid plant derived from the typical one. It is highly sterile on account of irregular meiosis. Its giant character might be due to its autotriploidy.

**242. Karyological studies on some flowers of *Crocus*.** Kôtarô KARASAWA. (Bot. Mag. Tôkyô **46**, 1932, 800-802, 6 figs.).

By examining the somatic chromosome number in six flowering *Crocus* the author has found 2 diploid, 1 tetraploid and 2 triploid plants, the basic number being 8. One was found to possess 15 chromosomes.

**243. Spodograms of the leaves of barley.** (Japanese with English résumé). Huzio KATOO. (Bull. Miyazaki Coll. Agric. & Forest. **4**, 1932, 87-109, 7 text-figs.).

The author has tried the identification of a certain number of Japanese barley strains by means of spodograms of their leaves. The strains used for this purpose were 7 in all, viz. 1 hexastichous, 5 distichous, and 1 tetrastichous. The spodograms of leaves were studied concerning their upper and lower surface. In the upper surface view the presence or absence of elongated cells running parallel to the veins as well as their outline (wavy or straight) will serve as the criterion of identification in many cases. Quartziferous cells and setiform hairs are often seen, and serve for the purpose of identification. The lower surface view shows nearly similar spodograms as the upper, except some minor differences.

An analytical key for the identification of strains studied by the author according to their spodograms is given.

**244 Chromosom-Aberranten bei *Pharbitis Nil*.** (Japanisch). Hitoshi KIHARA. (Kwagaku (Science) **2**, 1932, 196-198, 3 Textabb.).

Drei chromosomale Aberranten sind im IMAIS Linie "fleckd" aufgetreten, von denen die Blüten und Blätter von denen des normalen Typus abweichen. Chromosomengarnitur:  $15\text{II}$ , Aberranten (1)  $14\text{II} + 1\text{I}$ , (2)  $14\text{II} + 2\text{I}$ , (3)  $15\text{II}$  oder  $14\text{II} + 2\text{I}$ . Die Aberranten sind vollkommen steril, ausgenommen 1., wobei ein einziges Samen geerntet wurde.

**245. Über das Vorkommen von haploiden Pflanzen bei *Triticum monococcum*.** (Japanisch). Hitoshi KIHARA und Yoshikatsu KATAYAMA. (Kwagaku (Science) **2**, 1932, 408-410, 2 Textabb.).

In einer Kultur von *Triticum monococcum* sind drei haploide Pflanzen erschienen, entweder unter dem natürlichen Zustande oder nach der X-Strahlenbehandlung. Alle sind etwas kleiner als die originellen Pflanzen. In der ersten Reifungsteilung treten 7 Univalente auf, welche nach beiden Polen zufällig verteilt werden. Bei freier Bestäubung wurden wenige Samen geerntet. Die Parthenogenese dürfte in diesem Falle die Ursache der Haploidie sein.

**246. Different compatibility in reciprocal crosses of *Avena*, with special reference to tetraploid hybrids between hexaploid and diploid species.** (NISHIYAMA, The genetics and cytology of certain cereals III). Hitoshi KIHARA and Ichizo NISHIYAMA. (Japan. Jour. Bot. **6**, 1932, 246-305, 2 pls. and 51 text-figs.).

**247. Compositae novae japonicae III.** (With Japanese résumé). Siro KITAMURA. (Acta Phytotax. et Geob. **1**, 1932, 145-155).

Among the Compositae enumerated in this paper the following are new: *Aster taiwanensis*, *Cirsium arisanense*, *C. ferum*, *C. tenuisquamatum*, *Serratula diabolica*. All of them are described.

**248. An enumeration of Compositae of Formosa (I).** (With Japanese résumé). Siro KITAMURA. (Acta Phytotax. et Geob. **1**, 1932 277-296).

The paper contains the genera *Vernonia*, *Elaphantopus*, *Adenostemma*, *Ageratum*, *Eupatorium*, *Mikania*, *Solidago*, *Grangea*, *Dicrocephala*, *Rhynchospermum*, *Lagenophora*, *Myriactis*, *Aster*, *Heteropappus*. Each genus contains generally several species, and a key for their determination is given. *Eupatorium amabile*, *E. Shimadai*, *Solidago japonica*, and *Aster ovalifolius* are new.

**249. Contributiones ad cognitionem florum Asiae-Orientalis.** Gen'iti KOIZUMI. (Acta Phytotax. et Geob. **1**, 1932, 164-176).

Among the plants enumerated in this paper the following species are new and described: *Prunus superflua*, *Salix Arakiana*, *Viburnum sikokianum*.



**250. Plantae japonicae rarissime vel dubiae.** (Japanese). Gen'iti KOIDZUMI. (Acta Phytotax. et Geob. **1**, 1932, 225-233, 9 text-figs.).

In this paper nine plants are described with illustrations. The author has seen the specimens of all of them in the herbaria of Upsala, Leyden, Paris and Leipzig, but they are neither found in any herbarium in Japan, nor were reported ever to have been collected by any one. They are: *Laurus pedunculatus*, *Cinnamomum Sieboldii*, *C. brevifolium*, *Ranunculus Buergeri*, *Patrinia japonica*, *Potentilla rufescens*, *P. Savatieri*, *Epilobium axillare*, and *Dryopteris Goehringiana*.

**251. Über ein neues Fixierungsmittel.** (Japanisch). KOMURO-Hideo. (Kwa-gaku (Wissenschaft) **2**, 1932, 513-514).

Als wegen ihres hohen Preis die Beschaffung der für die Fixierung der pflanzlichen und tierischen Gewebe häufig gebrauchten Osmiumsäure schwierig ist, empfiehlt der Verf. das folgende neue Fixierungsmittel, welches aus gesättigter wässerigen Lösung von Pikrinsäure, 3% Kaliumbichromat und 1% Chromsäure zu 4, 3 und 3 respektiven Volumteilen besteht. Diese Mischung, welche dem Verf. bei der Fixierung verschiedener Gewebe der Menschen die vorzüglichen Resultate gab, dürfte auch bei der Fixierung von pflanzlichen Gewebe gleicherweise sehr dienstbar sein.

**252. Beziehung zwischen der Assimilation und dem Vorhandensein von Anthozyan in den vegetativen Teilen bei einigen Kulturpflanzen.** (Japanisch). Hiroshi KOSAKA. (Proc. Crop Sc. Soc. **4**, 1932, 38-44).

Der Unterschied der Kohlehydratmenge an den Blättern, welche am Abend bzw. am nächsten Frühmorgen gepflückt sind, ist als das während dieser Zeitdauer entstandene Assimilationsprodukt angenommen. Mittelst der Vergleichung der Blätter von *Perilla nankinensis* mit oder ohne Anthozyan in dieser Hinsicht konnte der Verf. nachweisen, dass das Assimilationsprodukt grösser ist an den ersteren als an den letzteren. Ebenso ist es der Fall bei den Blättern von Reispflanzen mit oder ohne Anthozyan, und zwar unter niedriger Temperatur (im Mittel 22, 3°), während bei höherer Temperatur (im Mittel 28, 2°) es gerade umgekehrt ist. Der Verf. kommt zum Schlusse, dass die anthozyanführenden Teile die Wärme absorbieren und damit ihre physiologische Funktion erhöhen. Bei Reispflanzen unter höherer Temperatur dagegen ist es wahrscheinlich, dass die Blätter zu viel Wärme absorbieren, und ihre physiologische Funktion gestört ist.

**253. Über den Einfluss des Lichtes, der Temperatur und des Wassermangels auf die Färbung der Chrysanthemum-Blüten.** Hiroshi KOSAKA. (Bot. Mag. Tôkyô **46**, 1932, 551-560).

Bei einer bei uns viel kultivierten Sorte *Chrysanthemum sinense* var. *hortensis* kommt es oft vor, dass die Blüten sich an den Kronen bzw. an ihrer Aussenseite rotviolett färben (Anthozyan!). Für die Entstehung dieser eigentümlichen Farbe ist das Licht der wichtigste Faktor, und unter der Beleuchtung ist die produzierte Anthozyanmenge bei höherer Temperatur viel kleiner als bei niedriger. Der Wassermangel trägt auch zur Entstehung dieser eigentümlichen Farbe bei.

**254. Physiologisch-anatomische Untersuchungen über die Verteilung der an verschiedenen Vegetationsorganen in Erscheinung tretenden Anthozyanfarbstoffe von einigen Pflanzen.** (Japanisch mit deutsch. Zfg.). Hiroshi KOSAKA. (Bult. Sc. Fak. Terk. Kjušu Imp. Univ. **5**, 1932, 185-207).

Die Untersuchung der anthozyanhührenden Pflanzen, *Abutilon avicennae*, *Chorchorus capsularis* und *Perilla nankinensis* hat gezeigt, dass das Anthozyan entweder in der Epidermis usw. oder im inneren Gewebe vorkommt. Für die Farbstoffproduktion in den peripheren Teilen ist die Sonnenbeleuchtung unbedingt notwendig, während für den gleichen Vorgang im inneren Gewebe die Nährstoffe von Bedeutung sind.

**255. Genera plantarum formosandarum. A description of all the genera of the vascular plants indigenous to Formosa and an enumeration of all the species, varieties and forms hitherto known in Formosa I.** Yushun KUDO et Genkei MASAMUNE. (Ann. Rpt. Taihoku Bot. Gard. **2**, 1932, 1-141).

The title of the paper above cited will clearly indicate its character. The first part just published contains the Dicotyledones beginning with the Saururaceae and ending with the Rosaceae according to the ENGLER's system. To each family and each genus the Latin diagnosis is given. Under each genus all species known hitherto in Formosa are cited with their respective literature. The paper ends with the index of families and genera. As one of the authors (KUDO) is dead, MASAMUNE will continue in future to publish the following parts, conjointly with YAMAMOTO.

**256. An ecological survey of the vegetation of the border of Lake Jitsugetsutan.** Yushun KUDO and Syun'iti SASAKI. (Ann. Rpts. Taihoku Bot. Gard. Fac. Agric. & Sc., Taihoku Imp. Univ., Formosa **1**, 1931, 1-50, 2 pls.).

Jitsugetsutan (or Zitugetsutan) is a fairly large lake in Middle Formosa. The authors have found there and in its border 70 species of trees, 9 of water-plants, 6 of root-climbers, 52 of winding lianes, 15 of tendril-climbers, 18 of epiphytes, and 3 of parasites. The authors have distinguished a number of associations, viz. kusu-kashi (*Cinnamomum-Quercus*) association, bog vegetation, water societies, and grass-land. Finally all plants there found by the authors are enumerated, Marattiaceae-Compositae.

**257. On certain experimental results concerning the over-elongation phenomenon of rice plants which owe to the filtrate got from the culture solution of the "bakanae"-fungi.** (Japanese). Eiiti KUROSAWA. (Rpt. Taiwan Nat. Hist. Soc. **22**, 1932, 198-201).

The author has formerly observed the fact that the peculiar over-elongation phenomenon of rice plants by the filtrate of the culture solution of the "bakanae"-fungus (*Lisea Fujikuroi*) is due to a certain substance secreted by the fungus which is produced only when acid potassium phosphate or potassium nitrate (or calcium nitrate) is contained in the solution. The author has studied the question, what constituent of each of these salts is responsible for the secretion of the substance causing the over-elongation. By replacing acid potassium phosphate by potassium sulphate

or chloride he could observe the phenomenon, but by replacing by calcium or sodium phosphate not, which led the author to the conclusion that potassium, but not phosphoric acid is essential for the occurrence of the phenomenon under question.

Further, the author has studied various properties of the secretion. It is insoluble in alcohol, ether, toluol, chloroform, xylol, carbon disulphide. It is non-volatile, permeable through collodion membrane, is adsorbed by powdered lime-charcoal, etc. It remains unchanged under high temperature, e.g. 100° under either dry or moist condition during a number of hours. It is resistant against cold and direct sunlight. It may lie dormant during 1-6 years.

**258. Cytological studies of *Colocasia*.** (Japanese with English résumé). Yosi-nori MAEDA. (Proc. Crop. Sc. Soc. **4**, 1932, 315-317, 3 text-figs.).

In *Colocasia antiquorum* and *gigantea* the haploid and the diploid chromosome number are 14 and 28 respectively, the size of chromosomes being somewhat larger in the latter than in the former. In meiosis some irregularities of chromosome behaviour are observed, and this may be the cause of sterility in *Colocasia*.

**259. *Alabastra diversa* I.** Fumio MAEKAWA. (Bot. Mag. Tôkyô **46**, 1932, 561-586, 13 text-figs.).

Among the plants enumerated by the author the following are new: *Arisaema aequinoctiale*, *A. limbatum*, *A. stenophyllum*, *Asarum hexalobum*, *A. crassum*, *A. tubulosum*, *A. kiusianum*, *A. melanosiphon*, *A. nipponicum*, *A. rigescens*, *A. nankaiense*, *A. asperum*, *A. minus*, *A. constrictum*, *A. Nakaianum*, *A. Hisauchi*, *A. Takaoi*, *A. stoloniferum*, *A. satsumense*, *A. curvistigma*, *A. pseudo-Savatieri*, *Epi-medium sempervirens*, *Polygonatum iyoense*, *Tovara smaragdina*.

**260. A table showing the distribution of all the genera of flowering plants which are indigenous to the Japanese Empire.** Genkei MASAMUNE. (Ann. Rpt. Taihoku Bot. Gard. **1**, 1931, 51-92).

An extensive table extending over 40 pages showing the distribution of 1437 genera indigenous to Japan in the following eight regions, viz. Kuriles, Sachalien, Yezo, Korea, Honsiu (incl. Kiusiu and Sikoku), Riukius, Formosa and Bonins.

**261. *Symbolae florae australi-japonicae* I.** (With Japanese résumé). Genkei MASAMUNE. (Jour. Soc. Trop. Agric. **4**, 1932, 191-197).

The following new species from Formosa are described among others: *Lysimachia nigropunctata*, *Ligustrum nokoensis*, *Eulophia Kitamurai*, *Plantago formosana*, *Shortia yakusimensis*, *Veratrum Kudo*, *Marus taihokuensis*, *Herminium nankotaizanense*, *Cheirostylis Tatewakii*.

**262. Phytogeographical position of Formosa when her indigenous genera are concerned.** (With Japanese résumé). Genkei MASAMUNE. (Trans. Nat. Hist. Soc. Formosa **22**, 1932, 164-194).



The author has shown in a tabular form the distribution of all genera of phanerogamous plants indigenous to Formosa in the neighbouring regions, viz. China, Philippines, Riukius and Japan proper, from which one can see that the mode of distribution is various in different families. The general conclusion drawn from this comparative study is that the flora of Formosa is most intimately related to that of China, then to that of Philippines, and lastly to that of Japan proper.

**263. Phytogeographical position of Formosa when her indigenous genera of vascular cryptogamic plants are concerned.** Genkei MASAMUNE. (Trans. Nat. Hist. Soc. Formosa **22**, 1932, 365-371).

The author's paper reviewed in No. 262 refers to the phanerogams. A similar study was made by the author concerning the vascular cryptogams. There are in Formosa 78 genera of indigenous vascular cryptogams. Of these 92%, 90%, 74% and 72% are found in China, Philippines, Japan proper, and Riukius respectively. The near relationship between the Formosan and the Chinese flora is quite evident.

**264. Notes on the orchid flora of Japan.** (With Japanese résumé). Genkei MASAMUNE. (Bot. Mag. Tôkyô **46**, 1932, 772-773).

5 Formosan orchid plants are enumerated, of which the following are new and described, viz. *Zeuxine Niijimai*, *Z. kantoikeiensis*, *Platanthera Sigeyosi*.

**265. Étude des types biologique d'après RAUNKIAER dans la flore aux environs de Garanbi.** (En japonais). Genkei MASAMUNE, Siduka KAMIKÔTI, Tokio SUZUKI et Noriaki HUKUYAMA. (Jour. Soc. Trop. Agric. **4**, 1932, 204-212).

L'étude d'un forêt vierge aux environs de Garanbi qui est situé à l'extrémité méridionale de l'île de Formose concernant les types biologiques d'après RAUNKIAER a été fait par les auteurs. Ils ont montré que le pourcentage des types biologiques est comme suit, phanérophytes à tiges succulentes 0,7, phanérophytes épiphytes 0, méga- et mésophanérophytes 21, microphanérophytes 42,6, nannophanérophytes 17,5, chaméphytes 15,4, hemicryptophytes 4,2, géophytes 0,7, hydrophytes et héliophytes 0, et thérophytes 16,8. L'abondance des phanérophytes est remarquable.

**266. Immunological studies of mosaic diseases II. Distribution of antigenic substance of tobacco mosaic in different parts of host plants.** (With Japanese résumé). Takashi MATSUMOTO and Kôetsu SOMAZAWA. (Jour. Soc. Trop. Agric. **4**, 1932, 161-168).

It was formerly shown by one of the authors that the leaf extract of tobacco mosaic, when injected into the rabbit, stimulates the production of specific precipitating antibodies (cf. Japan. Jour. Bot. **5**, 40, No. 129). This time the authors have used instead of leaf extract that made from various parts of stems and roots as well as flower-buds which do not show any symptom of mosaic disease, and found that the same stimulating action occurs also in these cases. The experiments have also shown that the concentration of the antigenic substance was nearly the same in expressed juices of fresh leaves and roots which are either fresh or dried; it was highest in those



of dried leaves and lowest in those of stems especially in dried ones. Another series of the experiments has shown that the formation of the antigenic substance goes parallel to the multiplication of the infective agent, thus for instance any reaction was hardly visible in inoculated plants within less than 4 days incubation. It was shown that the antigenic substance first appears in the portion above the inoculated part, next at the subterranean part, and then in lower part of the stem, though the leaves belonging to the latter seem to contain yet no antigenic substance. All in all the author confirms the interpretation of Purdy BEALE that the antigenic substance of tobacco mosaic is possibly the virus itself, and not the altered host protein.

**267. Physiology and parasitology of the fungi generally referred to as *Hypochnus Sasakii* SHIRAI. I. Differentiation of the strains by means of hyphal fusion and culture in differential media.** Takashi MATSUMOTO and Kôetsu SOMAZAWA. (Jour. Soc. Trop. Agric. **4**, 1932, 270-388).

A number of strains of *Hypochnus Sasakii* were tested to study their phylogenetic relationship. First of all, the hyphal fusions were examined. It was observed that in some strains a perfect fusion occurs, quite similarly as in the hyphae derived from the same mycelium, which indicates their identity and was confirmed by the similarity in their morphological characters. Between the less related strains an imperfect hyphal fusion occurs, i.e. the cell-membrane of both hyphae in contact becomes incompletely dissolved, or their contents do not mix. In still less related strains the hyphae come simply into contact, but no fusion occurs at all. Neither fusion nor contact takes place between any strain of *Hypochnus Sasakii* and *Rhizoctonia Solani* which is often confused with the former.

The authors have further examined the behaviour of the strains in the CZAPEK's or DUGGAR's agar containing a certain quantity of various dyes, as pherol red, chlorphenol red, bromphenol, etc., etc. Though the reaction of various strains against these dyes was somewhat different it will not suffice for their identification.

**268. Experimental studies on the saltation in fungi VI. (Preliminary report). On the saltation in the genus *Brachysporium*.** (Japanese). Isamu MATSUURA. (Jour. Plant Prot. **19**, 1932, 121-139, 1 pl. and 1 text-fig.).

The experiments are concerned with various races of *Brachysporium* parasitic on *Cynodon Dactylon*, *Setaria italica*, red pepper and *Cyperus Iria*. The phenomenon is very similar in all cases. In the author's culture of *Brachysporium* he found besides normal black mycelial growth certain white patches. The culture from a single spore of the latter has shown the constancy of this saltation during several generations, except a few cases where the return, either wholly or partial, to the original colour was seen. The original and the saltant races differ simply in the colour of mycelia. The pathogenicity of *Brachysporium* from *Cynodon* was found to be stronger towards *Cynodon* and weaker towards rice plant than it was the case in the original race. The exposure to X-rays does not increase the frequency of saltations.

**269. Experimental studies on the saltation in fungi. (Preliminary report) VII. On the mechanism of the occurrence of "island" type of saltation.** (Japanese). Isamu MATSUURA. (Jour. Plant Prot. **19**, 1932, 409-428, 1 pl.).

When filiform fungi are cultivated during long time on the same nutrient medium, aerial hyphae fall down partly, showing watery lustre. This has been observed by STEVENS in *Helminthosporium* and was called the senescence phenomenon of aerial mycelium. The author has observed also in *Helminthosporium* the same phenomenon, not however in old culture, but in that only 2-3 days old. He observed that from the under-surface of mycelial strands a liquid is secreted and all hyphae on them were observed to sink down under it—what the author calls pseudomyceliose. Such mycelial strands become slender and weak. In the formation of “island-like saltants” in *Helminthosporium* (cf. Japan Jour. Bot. 5, (68), No. 230) the author could observe at first this sinking of mycelial strands under the liquid, and he came to the conclusion that the saltation is due to the action of a certain metabolism product of the fungus itself contained in the liquid under question.

**270. Morphology of lotus (*Nelumbo*) flower, especially of two-headed flower.** (Japanese.) Shigeru MIKI (Bull. Sci. Res. Alumni Assoc. Morioka Coll. Agr. and Forest. 7, 1932, 42-52, 3 pls. and 7 figs.).

From a careful study of two-headed lotus flower, the author concludes that the normal flower is pseudo-terminal, there being one or more flower-buds not developing. The simple peduncle of *Nelumbo* corresponds therefore to the leafy shoot of *Brasenia* and the so-called sepal of *Nelumbo* to the bract.

From the fact that the flower shoot is formed in transversal position to the vegetative shoot, the author concludes that the family is closely related to the Hydrocharitaceae than to the Potamogetonaceae.

Author.

**271. Ecological studies of the forest at Jingu-shin-iki.** (Japanese.) Shigeru MIKI (Publ. of Jingu-Shicho 1932, 75 pp., 7 pls., 2 figs.).

“Jingu-shin-iki” in Prov. Ise, the most sacred shrine forest of Japan which has been preserved since more than one thousand years ago in its natural condition with luxuriant growth of vegetation, has some features which are ecologically interesting.

In this region where wild boar and deer wander about, *Illicium anisatum*, a toxic tree and *Damnacanthus indicus* var. *genuinus*, a spiny shrub, markedly predominate. Though there are various kinds of trees in climax growth, most of them are not accompanied by their offspring, except *Lithocarpus cuspidata* and *Rapanea neriifolia*, which may constitute therefore the dominant tree of the forest in the future.

Author.

**272. On sea-grasses new to Japan.** Shigeru MIKI. (Bot. Mag. Tôkyô 46, 1932, 774-788, 1 pl. and 9 text-figs.).

Among eight genera of sea-grasses 6 were known to be present in Japan. The author's discovery of a new species of *Diplanthera* (*D. pinifolia*) in Riukiu and Formosa has increased this number to 7. Three new species of *Zostera* were discovered also by him, viz. *Z. asiatica*, *caulescens* and *caespitosa*. All are described in detail with plenty of illustrations.

**273. On the curvature of the culm of *Sasa kurilensis*.** Katsutaro MIURA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. 7, 1932, 529-542, 11 text-figs.).

*Sasa kurilensis*, a bamboo which grows wild in the mountain regions of Northern Japan is characterized by their culms curving at the base. A rhizome grows parallel to the soil surface, whether the ground is inclined or not. New rhizomes are produced either from its last node or from a node of the culm under ground. The culm curves once concavely under ground (first type) or twice concavely under ground and convexly near the soil surface (second type), the latter being common in adult plants. The culm begins to curve at its 7-8th node, and becomes straight at about the 20th node.

**274. On *Hedophyllum Bongardianum* (P. et R.) YENDO and five species of *Laminaria* from the North Kuriles.** Kingo MIYABE and Masaji NAGAI. (Trans. Sapporo Nat. Hist. Soc. **12**, 1932, 194-205, 1 pl. and 4 text-figs.).

A detailed description of the following species is contained in this paper, viz. *Hedophyllum Bongardianum*, *Laminaria longipes*, *L. taeniata*, *L. cuneifolia* f. *subsimplex*, *L. platymeris*, and *L. dentigera*.

**275. Some observations on the microsporogenesis of the haploid plant of rice.** Toshitaro MORINAGA and Eiji FUKUSHIMA. (Proc. Imp. Acad. **8**, 1932, 404-405, 8 text-figs.).

Concerning the haploid rice plant obtained by the authors (cf. Japan. Jour. Bot. **5**, (12), No. 36) they have studied the meiosis during the microsporogenesis. 12 chromosomes were seen which are arranged irregularly and form no equatorial plate. The second division is regular. It is quite evident that among 12 chromosomes no homologous ones are present.

**276. Chromosomzahlen und Fertilitätsverhältnisse in der Nachkommenschaft eines hypopentaploiden *Triticum*-Bastarde mit 34 somatischen Chromosomen.** (Japanisch m. deutsch. Zfg.) Mikio MORIYA. (Japan. Jour. Gen. **8**, 1932, 34-47, 23 Textabb.).

Ein 34-chromosomiger Bastard, welcher durch die Kreuzung, 40-chromosomiger Zwerg  $\times$  *Triticum polonicum* ( $n = 14$ ) entstanden ist, zeigt die Chromosomenkombination  $14_{II} + 6_I$ . Der Bastard gehört zur Verminderungsgruppe im Sinne von KIHARA. Bei 69% seiner Nachkommen sind "fertile" und bei 31% "sterile" Kombinationen gefunden. Es wurde weiter festgestellt, dass die Fruchtbarkeit der fertilen Kombinationen mit der Verminderung der Univalente steigt, während bei den sterilen irgend eine Beziehung zwischen der Fertilität und der Kombinationsweise nicht zu sehen ist.

**277. Recherches sur les spermatozoïdes végétaux. I. Sur le rhéotactisme des spermatozoïdes de Filicinées.** Jean MOTTE. (Cytologia **3**, 1932, 377-383).

L'auteur a étudié, à l'aide d'un rhéomètre de sa fabrication la réaction des spermatozoïdes de quatre espèces de fougères à un courant d'eau de vitesse variable. Il décrit particulièrement les recherches dont *Pteris cretica* fut l'objet, et conclut que les spermatozoïdes de fougères sont doués d'un rhéotactisme positif apparaissant dès que le courant dépasse 2,3 mm/sec. Les spermatozoïdes nagent, dès lors, contre le



courant avec une vitesse de plus en plus grande, mais dont l'accélération décroît à mesure que le courant devient plus rapide. La courbe représentant la vitesse des spermatozoïdes par rapport à la vitesse de l'eau a donc un aspect parabolique.

Auteur.

**278. The number of leaf-stomata in relation to a spot-leaved mutant in rice.** (Japanese). Isaburo NAGAI. (Ann. Agric. Exp. Sta. Gov.-Gen. Chosen (Tyôsen) **6**, 1932, 345-346).

A variegated mutant of paddy rice derived from a Korean race is recessive to the latter. The segregation between the original and the mutant form in 3:1 ratio was observed. The difference of the number of stomata between these two races is  $68.27 \pm 13.3$  in respect to upper surface and  $63.62 \pm 11.53$  in respect to lower, that number being greater in variegated than in the original plant. It is to be remarked that each of these differences is more than 3 times the standard error.

**279. On the leaf-stomata of rice plant.** (Japanese). Isaburo NAGAI and Moriziro SUZUKI. (Ann. Agric. Exp. Sta. Gov.-Gen. Chosen (Tyôsen) **6**, 1932, 338-344).

The number of stomata in each leaf of rice plant increases parallel to its growth, e.g. 501.7 pro leaf in very young stage against 4571 in adult stage. It is variable according to the difference of leaf position on the shoot (179.4 pro leaf at its tip and 176.6 at its base against 680.4 at its median part.) In upper surface 566.02, in lower 681.01. In paddy rice 501.75, in land rice 757.4. The manuring has also a certain influence on the number of stomata, e.g. in the Aikoku race under a certain manuring 503.66 against that under double manuring 635.35. The number is also different in different races, and it was observed that the greater the number of stomata the greater that of plants dying under blast disease.

**280. Über die Chromosomen einiger Amaryllidaceen.** (Japanisch m. deutsch. Zfg.). Seijin NAGAO und Harusige TAKUSAGAWA. (Bot. Mag. Tôkyô **46**, 1932, 473-478, 32 Textabb.).

Die Chromosomenzahl (haploide oder diploide) von sieben Amaryllidaceen wurde festgestellt. Sie schwankt zwischen 22 und 46 (diploid!) Die Verkettung der Chromosomen wurde in einigen Fällen beobachtet.

**281. Notulae ad plantas japoniae et koreae XLII.** (With Japanese résumé). Takenoshin NAKAI. (Bot. Mag. Tôkyô **46**, 1932, 603-638, 651-658, 1 text-fig.).

The following new species are described among others: *Gagea coreana*, *Saussurea rectinervis*, *Cirsium xanthacanthum*, *C. liukiunense*, *C. hachijoense*, *C. Tobai*, *C. ruderale*, *C. lacinulatum*, *C. ibukiense*, *C. senile*, *C. tonense*, *C. ugoense*, *C. apoense*, *Rhododendron sanctum*.

**282. On the appearance of the triploid plant of rice, *Oryza sativa* L.** Eiiti NAKAMORI. (Proc. Imp. Acad. **8**, 1932, 528-529, 2 figs.).



In the eighth generation of a cross of two certain rice races the author has found an abnormal plant which differs morphologically in various respects from either parent. The examination of the root-tip cells has revealed 36 chromosomes, that is the plant is triploid, as compared with the ordinary races with  $n = 12$ ,  $2n = 24$ . A few plants produced by the self-pollination of this plant were abnormal in their shape, and showed 25-29 chromosomes in their root-tip cells.

**283. Daily changes in the occurrence of the imperfect pollen grains in *Impatiens Balsamina* Linn.** Miyawo NAKAMURA. (Jour. Soc. Trop. Agric. **4**, 1932, 149-160, 28 text-figs.).

The author has observed in a variety of *Impatiens Balsamina* a remarkable fluctuation in the number of imperfect pollen grains and that of sterile seeds which may vary from 9 to 100% and from 7 to 100% respectively. Such fluctuation takes place because the meiosis for the pollen formation may be either regular or irregular. Normal division is seen when the maximum of air temperature is lower than 30°C, whilst the abnormal one occurs when its maximum is higher than 33°C. The irregularities of meiosis may take place in various ways, viz. non-conjugation of chromosomes, their non-disjunction, too early splitting, non-splitting, lagging, grouping, scattering or arranging in one row, etc., and the consequent formation of polyads.

**284. Difference in peroxylase activity of the cotton species.** (Japanese). Sadao NAKATOMI. (Proc. Crop Sc. Soc. Japan **4**, 1932, 295-303).

The intensity of peroxylase action in various species of cotton plant was examined by adding to the liquid obtained from seeds crushed in water (except seed-coat) 1% guaiaicol and 2%  $H_2O_2$ , and by observing the intensity of the colouration of the liquid. It was found that this action is much more intense in Old World cotton mit 26 chromosomes than in New World one with their double number. Further, a very remarkable fact was observed that different species having the same number of chromosomes do not differ considerably in their peroxylase activity. In  $F_1$  plants derived from the two parents with different chromosome number either this activity lies intermediate between them or that of the one parent dominates to that of the other.

**285. On the flower types of *Diospyros Kaki*, L. fil.** Isawo NAMIKAWA, Makoto SISA and Kehtaro ASAI. (Japan. Jour. Bot. **6**, 1932, 139-172, 23 text-figs.).

**286. Studien über die Bakanae-Krankheit.** (Japanisch). I. Yosikazu NISIKADO. II. Yosikazu NISIKADO und Hiroyosi MATUMOTO. (Nôgaku Kenkyû (Landw. Studien) **19**, 1932, 309-331, 6 Abb. und 333-358, 6 Abb.).

Für die vorliegenden Studien wurden die Rassen von *Fusarium monoliforme* var. *majus*, welche aus dem Zuckerrohr von Java und Mexico stammen, zwei Rassen von *F. monoliforme* aus Mais von gewissen Gegenden von Nordamerika, weiter *Lisea Fujikuroi* aus Formosa und Kyôto benutzt. Einer der wichtigsten Schlüsse der Verf. Experimente, welche auf verschiedene obengenannte Erreger der Bakanae-Krankheit gegründet sind, ist wie folgt. Der Erreger der in Rede stehenden Krankheit verur-

sacht eine Überverlängerung des Organes (charakteristisches Symptom dieser Krankheit), nicht nur an Reis und Mais, sondern auch an den anderen Gramineen, z. B. *Sorghum*, Gerste, *Panicum miliaceum*, Zuckerrohr usw., und somit ist sie keineswegs auf Reis beschränkt.

**287. Über eine neue einfache Methode, das Photographieren und das Zeichnen des Pilzsporen zu erleichtern.** (Japanisch). Yosikazu NISIKADO. (Nôgyô Kenkyû (Landw. Studien) **19**, 1932, 359-360).

Indem das Photographieren und das Zeichnen der Pilzsporen im Wasser unter Deckglas keineswegs leicht auszuführen ist, wegen ihrer leichten Beweglichkeit, benutzt man jetzt oft auf Vorschlag von SHERBAKOFF als das Einbettungsmittel das Agar statt des Wassers, was sich gut bewährt hat. Da jedoch das bereitete Agar aus verschiedenen Gründen (z. B. Pilz- oder Bakterieninfektion) bald unbrauchbar wird, so hat der Verf. für den gleichen Zweck den Gebrauch des käuflichen Kollodiums vorgeschlagen. Dazu fügt man dem letzteren die Mischung von Alkohol abs. 1 + Aether 3 hinzu (4-5-fach), worin man das Deckglas hineintaucht. Nach dem Trocknen beseitigt man die dünne Kollodiumhaut auf einer Fläche desselben, und in der Mitte der Kollodiumhaut an der anderen legt man etwas Wasser und darin die Pilzsporen. Nach einiger Zeit legt man dies Deckglas mit der Kollodiumhautseite nach unten auf den Objektträger, wozu man vorher einige Tropfen Wasser gelegt hat. Überflüssiges Wasser wird beseitigt, das Deckglas wird mit Paraffin umgerandet, und jetzt ist das ganze für das Photographieren usw. fertig.

**288. On the structure of "hobashira-ishi", a famous silicified trunk at Najima near Fukuoka City.** Yudzuru OGURA. (Japan. Jour. Bot. **6**, 1932, 173-181, 1 pl. and 4 text-figs.).

**289. On the structure of a silicified wood found near "hobashira-ishi" at Najima near Fukuoka City.** Yudzuru OGURA. (Japan. Jour. Bot. **6**, 1932, 183-190).

**290. On the systematic importance of spodograms in the leaves of the Japanese Bambusaceae.** Kiichi OHKI. (Jour. Fac. Sc., Imp. Univ. Tôkyô, Sect. III, **4**, 1932, 1-130, 43 text-figs.).

The identification of various species of the Bambusaceae is not very easy. The author has begun long ago to study their spodograms to use them for the criterion of their identification, and published already on several occasions the results of his studies (cf. Japan. Jour. Bot. **4-5**, Abstracts). The present is the full paper of such results preliminarily reported till now. Firstly, an analytical key for the identification of genera according to the spodograms is given, including *Shibatea*, *Bambusa*, *Sasa*, *Pseudosasa*, *Sasaella*, *Semiarundinaria*, *Sinobambusa*, *Chimonobambusa*, *Pleioblastus*, and *Phyllostachys*. Then follows the description of the spodograms of each species contained in these genera, generally with illustrations. Finally the various characters of the spodograms in the leaves of various species contained in the genera *Bambusa*, *Sasa*, *Pseudosasa*, *Sasaella*, *Pleioblastus*, and *Phyllostachys* are compared in a tabular form.

**291. Studien über den Konjakmannan-Abbau bei Schimmelpilzen.** (Japanisch). Torao OHTSUKI. (Bot. Mag. Tôkyô, **46**, 1932, 461-472).

Die Reinkultur von 27 *Aspergillus*-Arten wurde auf Nährboden, der aus 0.25 g  $MgSO_4$ , 2.7 g  $NH_4Cl$ , 0.3 g  $KH_2PO_4$ , 10 g Konjakmannan und 1 l. Wasser bestand, hergestellt. Das Konjakmannan, das einzige organische Bestandteil des Nährbodens war, wurde, wie in der früheren Mitteilung beschrieben, rein zubereitet (vgl. Acta Phytochimica, **4**, 1. 1928). 1. Die Pilze gedeihen darauf schnell, ausser einigen wenigen Arten wie *A. varians*, *A. repens*, *A. glaucus*. 2. Der Boden, der am Versuchsbeginn fest ansah, wurde durch wachsende Myzelien allmählich verflüssigt. Dabei findet die Verzuckerung des Mannans statt, deren Gang zeitlich verfolgt und zahlenmässig angegeben wurde. 3. Nach bestimmter Kulturdauer wurde die Nährflüssigkeit gereinigt und auf Mannosehydrazon bzw. Glucosazon erprobt, wobei das erstere bei 15, das letztere bei 23 Pilzarten positiv ausfiel. 4. Enzymatischer Abbau des Konjakmannans wurde hinsichtlich des Ectoenzym sowie Endoenzym ausgeführt. Bei Ectoenzymversuchen wurden Verflüssigung des gallertartigen Konjakmannanhydrosols, Steigerung des Reduktionsvermögens und Glucosazonbildung bei allen 22 Arten positiv gefunden, aber Mannose wurde bei 17 Arten positiv und bei 5 Arten negativ erprobt. Endoenzym wirkt noch stärker auf das Konjakmannan. Verflüssigung sowie Glucose- und Mannosebildung fand bei allen Pilzen statt, ausser nur einer Art (d.h. bei *A. melleus* war Mannosebildung negativ). 5. Das Versuchsergebnis bei Ectoenzym weicht von dem des früheren Autors (MAYEDA) ab, der überhaupt die Mannosebildung verneinte. Die Versuche von MAYEDA wurden vom Verf. mit dreierlei Nährböden (einer davon enthielt 0.2% Kaliumnitrit als N-Quelle; Pilze wuchsen hier auch gut) wiederholt, wobei die Mannosebildung bei Ecto- sowie Endoenzym immer positiv ausfiel. 6. Käufliche Konjaktafel, die als Esswaren aus Konjakmannan mit Kalkmilchzusatz dargestellt wird, wurde auch als Nährboden benutzt. Pilzwachstum (27 Arten) war gut aber etwas langsamer als bei 1. Verf.

**292. Florula shikotanensis II.** Jisaburo OHWI. (Acta Phytotax. et Geob. **1**, 1932, 111-131).

Continuation of the enumeration of plants collected in Sikotan in Kuriles (cf. Japan. Jour. Bot. **5**, (48), No. 163.) It begins with *Adoxa moschatellina* (No. 162) and ends with (No. 321) *Empetrum nigrum*.

**293. Symbolae ad floram Asiae-Orientalis V-VI.** (With Japanese résumé). Jisaburo OHWI. (Acta Phytotax. et Geob. **1**, 1932, 140-144, 297-305.)

The following new species are enumerated among others and described: *Tripterygium Doianum*, *Habenaria cucirrhifera*, *Calamagrostis Sugawarai*, *Carex kujuzana*, *C. Tatewakiana*, *Cyperus Shimadai*, *Mitella Doiana*.

**294. Bacterial diseases of plants occurring in Formosa. I.** Norio OKABE. (Jour. Soc. Trop. Agric. **4**, 1932, 470-485, 5 text-figs.).

The following plant diseases in Formosa are described concerning their symptoms, causal organisms (with their morphological and cultural characters), inoculation,



identification, name of pathogenes, materials from which the latter were isolated, and hosts.

1. Bacterial pustule of soy bean (*Bacterium phaseoli sojense* HEDGES)
2. Bacterial leaf spot of castor bean (*B. ricini* YOSHII et TAKIMOTO)
3. *Citrus* canker (*B. citri* DODGE)
4. Bacterial black spot of radish (*B. maculicola* McCULLOCH)
5. Angular leaf spot of cotton (*B. malvacearum*)
6. Black spot of crucifers (*B. campestre* E. F. SMITH).

**295. Parthenogenesis bei *Ixeris dentata* Nakai.** (Japanisch m. deutsch. Zfg.). Sakuichi OKABE. (Bot. Mag. Tôkyô 46, 1932, 518-523, 15 Textabb.).

Der Verf. hat in den Wurzelspitzenzellen von *Ixeris dentata* 21 Chromosomen nachgewiesen, was auf ihre triploide Natur hindeutet. Wegen der unregelmässigen Kernteilung werden die Pollenkörner verschiedener Grösse ausgebildet. Bei der Kernteilung in der Embryosackmutterzelle findet keine Tetradenteilung statt; 21 Chromosomen bilden keine Gemini, und jedes derselben wird langgestreckt und zeigt eine Längsspalt wie bei somatischer Kernteilung. Keine Reduktionsteilung wird somit ausgeführt. Im fertigen Embryosack sieht man eine Eizelle, zwei Synergiden, zwei Polkerne und drei Antipodenkerne. Die Eizelle entwickelt sich ohne Befruchtung zum Embryo, wobei man 21 Chromosomen zählen kann. Wir haben also hier mit einem Fall der somatischen Parthenogenesis vom *Antennaria*-Typus zu tun.

**296. Über den Gaswechsel des Pollens.** Kazuo OKUNUKI. (Bot. Mag. Tôkyô 46, 1932, 701-721, 15 Tab.).

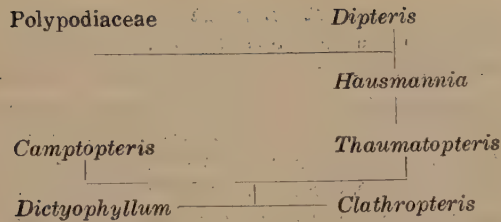
Mittelst der Methode WARBURGS hat der Verf. den Gaswechsel des Pollens bei *Camellia japonica* und *Lilium auratum* untersucht. Danach ist der Gaswechsel bei dem noch in den Antheren enthaltenen Pollen sehr gering, doch wenn er auszukeimen beginnt, wird es lebhaft. Dieser Vorgang wird bei *Camellia* stark befördert bei der Zugabe von Rohrzucker. Der Zusatz von Ionen wirkt auf diesen Vorgang hemmend, so z.B. bei der Sauerstoff-Aufnahme in *Camellia japonica* wie folgt:  $\text{NO}_3 > \text{SO}_4 > \text{CH}_3\text{COO} > \text{PO}_4 > \text{Cl} > \text{H}_2\text{O}$ ,  $\text{Li} > \text{K} > \text{Na} > \text{Mg} > \text{Ca} > \text{H}_2\text{O}$  usw.

Verf. hat weiter den hemmenden Einfluss der Ionen bei *Camellia* hinsichtlich der  $\text{CO}_2$ -Abgabe bei der Anaerobiose und der Streckung des Pollenschlauches bei Aerobiose und Anaerobiose studiert. Gleichartige Untersuchungen wurden auch bei *Lilium auratum* ausgeführt.

**297. On the fossil Dipteridaceae.** (Japanese). Saburô ÔISHI. (Acta Phytotax. et Geob. 1, 1932, 132-139, 4 text-figs.)

According to the author we may distinguish in the Dipteridaceae two groups according as the leaf-lamina and the chief axis make a certain angle (*Thaumatopteris*, *Hausmannia*) or they lie in one plane (*Dictyophyllum*, *Clathopteris*, *Camptopteris*). The phylogeny of the various genera of this family will be as follows:





**298. Zur Bildung des Wuchsstoffs bei *Aspergillus niger*.** Tetsu SAKAMURA und Tadashi YANAGIWARA. (Proc. Imp. Acad. **8**, 1932, 397-399).

Dank den Untersuchungen vieler Forscher ist es bekannt, dass viele Pilze und Bakterien einen Stoff ausscheiden, welcher die Wachstumsgeschwindigkeit der *Avena*-Koleoptile beschleunigt. Nach den Untersuchungen der Verf. über *Aspergillus niger* wurde die Produktion des Wuchsstoffes nachgewiesen, wenn man die peptonhaltige Kulturlösung ohne Zusatz des Zuckers verwendet. Es ist ersichtlich, dass der Wuchsstoff ein Spaltungsprodukt des Peptons bzw. der Aminosäuren ist. BOYSEN-JENSEN hat ja die Tatsache nachgewiesen, dass viele Aminosäuren als Wuchsstoffbildner dienen können. Um festzustellen, dass diese Wachstumsbeschleunigung auf die Enzymwirkung beruht, und von der Sauerstoff-Atmung unabhängig ist, haben die Verf. zuerst die Myzelien unter Wasser zerrieben, und der in solcher Weise bereitete Brei wurde als Enzympräparat verwendet, mit Hinzufügung des Peptons und der Phosphorsäure oder des Phosphates. Nach gewisser Zeitdauer wurde das Filtrat aus der Lösung auf dem Vorhandensein des Wuchsstoffes geprüft mit positivem Resultat. Die Unabhängigkeit der Wuchsstoffwirkung von der Sauerstoffatmung wurde somit sichergestellt.

**299. Beobachtungen über japanische Moosflora II-III.** K. SAKURAI. (Bot. Mag. Tôkyô **46**, 1932, 496-509, 737-750).

Unter den vom Verf. enumerierten japanischen Moosarten sind viele neu und beschrieben.

**300. Systematic and anatomical studies on the Japanese Juncaceae (3).** (Japanese). Yosisuke SATAKE. (Bot. Mag. Tôkyô **46**, 1932, 639-650, 8 figure-groups).

Continuation of the author's studies on the Juncaceae (cf. e.g. Japan. Jour. Bot. **5**, (16), No. 54). A key for the identification of five Japanese species of *Luzula* according to the anatomical structure of their carpels is given, and followed by the description of the anatomy of carpels of each species. The identification of various species of *Juncus* and *Luzula* according to the anatomical structure of peduncles is discussed; and a key for the determination of the species of both genera and the description of each species based on this criterion with illustrations is given.

**301. Studien über die Frühling- und Winterformen von Gerste.** (Japanisch). **II. Über den Unterschied der Saugkraft der Samenkörner.** Kenkiti SATÔ und Wako YOSINAGA. **III. Unterschied der Chlorophyllmenge.** Kenkiti SATÔ.

**IV. Kältewiderstand, Trockensubstanzmenge und physikalische Eigenschaft des Zellsaftes.** Kenkiti SATÔ und Saburô NAKASIMA. (Ann. Agric. Exp. Sta., Gov.-Gen. Chosen (Tyôsen) **6**, 1932, 201-214; 245-261, 1 Textabb.; 262-283, 1 Textabb.).

Zu II. Die Verf. haben nach BUCHINGER die Keimung der Samenkörner in der Rohrzuckerlösung verschiedener Konzentration studiert, um ihre Saugkraft zu bestimmen. Danach ist die Saugkraft der Samenkörner grösser bei den Winter- und Zwischenformen als bei der Frühlingsform. Auch in betreff der letzteren ist die Saugkraft bei den Rassen mit nackten Körnern etwas grösser als bei denselben mit beschalten. Die Saugkraft und die Sauggeschwindigkeit gehen nicht parallel, indem die Sauggeschwindigkeit kleiner ist bei Winter- und Zwischenformen mit grosser Saugkraft als bei der Frühlingsform. Weiter wurde die enge Beziehung zwischen der Grösse der Saugkraft und der Kältewiderstandsfähigkeit festgestellt, insofern als die Winter und die Zwischenformen in beiden Hinsichten die Frühlingsform zu übertreffen nachgewiesen wurden.

Zu III. Vergleicht man die Menge des in der Frühlings- und Wintergerste enthaltenen Chlorophylls zu einander, so wird man sehen, dass sie im Herbst weit grösser ist in der letzteren als in der ersteren, während im Frühling es ganz umgekehrt ist. Betreffs dem Reaktionsgrade von beiden Formen gegen Beleuchtung findet man, dass im Frühling er weit grösser ist bei der chlorophyllreichen Frühlingsform als bei der chlorophyllarmen Winterform (einschl. Zwischenform); im Herbste ist trotz der Armut der Chlorophyllmenge der Reaktionsgrad gegen Beleuchtung grösser bei der Frühlingsform als bei der Winterform. Die Kälteresistenz ist mit der Chlorophyllmenge eng verknüpft, insofern als die chlorophyllreichen Winter- und die Zwischenformen weit widerstandsfähiger sind als die chlorophyllarmen Frühlingsformen.

Zu IV. Wenn die Kälteresistenz im allgemeinen grösser ist bei den Winter- und Zwischenformen als bei der Frühlingsform, ist sie nach verschiedenen Rassen höchst verschieden, besonders bei der Zwischenform. Die Menge der Trockensubstanz ist grösser bei der Winterform als bei der Frühlingsform, und je kälter, je grösser wird dieser Unterschied sein. Im Herbste findet man die grösste Menge der Monosaccharide in der Winterform; dann folgt die Zwischenform und bei der Frühlingsform ist sie am kleinsten. Die Zellsaftkonzentration zeigt einen grossen Unterschied zwischen beiden Gerstenformen im Herbst unter der niederen Temperatur, wenn im Frühling unter höherer Temperatur dieser Unterschied winzig klein ist, was mit der Kältewiderstandsfähigkeit gut übereinstimmt, insofern als je konzentrierter der Zellsaft ist, je widerstandsfähiger die Form ist. Das ganz gleiche Verhalten beobachtet man auch sowohl bei pH als bei der Oberflächenspannung des Zellsaftes.

**302. Materials of the Formosan fungi (29).** (Japanese). Kanekichi SAWADA. (Trans. Nat. Hist. Soc. Formosa **21**, 1931, 330-338).

The following new species are described among others: *Cercospora Thladianthae*, *Mutinus quadrigenus*, *Peronoplasmodium Cucumeris*, *P. Luffae*, *P. Momordicae*, *P. Actinostemmae*.

**303. Studies on flowering, pod-bearing and seed-setting habits of alfalfa.** (Japanese with English résumé). Tôhei SAWADA. (Ann. Agric. Exp. Sta., Gov.-Gen. Chosen (Tyôsen) **6**, 1932, 215-229, 5 text-figs.).

In alfalfa the lowest raceme of the main axis begins to flower at first, and then this process goes on acropetally towards the successive racemes. Follows then the flowering of racemes on branches. The number of flowers in each raceme on the main axis is on the average 20 and in that of branch 13.8. The number of ripe pods is on the average 27.5 (1929) or 23.5 (1930) pro 100 flowers. That of seeds is 3.24 per pod etc., etc.

**304. Chromosomenzahlen bei japanischen Gartenrassen von *Chrysanthemum*.** (Japanisch m. deutsch. Zfg.). Naomasa SHIMOTOMAI. (Bot. Mag. Tôkyô 46, 1932, 690-700, 10 Textabb.).

Der Verf. hat die somatische Chromosomenzahl von 60 in Japan kultivierten *Chrysanthemum*arten untersucht. Bei 20 Rassen von "Bunzingiku" mit kleinen Köpfchen und einfachen Zungen, welche den wilden Arten viel näherer sind, als die anderen, schwankt sie zwischen 54 und 55. Dagegen, bei 40 Rassen von "Dairingiku" mit grossen Köpfchen und stark entwickelten Zungen, welche somit von den wilden Arten weit entfernt sein dürften, ist die Variabilität der Chromosomenzahl weit grösser, da sie zwischen 53 und 67 schwankt. Die Chromosomenzahl von wilden Arten ist 18, 36, 54, 72, 90. Als die von "Dairingiku" 53-67 beträgt, betrachtet der Verf. es wahrscheinlich, dass die letztere Rasse ursprünglich von den wilden Arten mit 54 Chromosomen, z.B. *C. morifolium* aus angekommen sein dürfte.

**305. Eigenartige Vermehrung der Chromosomenzahl bei den Artbastarden von *Chrysanthemum*.** (Japanisch mit deutsch. Zfg.). Naomasa SHIMOTOMAI. (Bot. Mag Tôkyô 46, 1932, 789-799, 7 Textabb.).

Die Kreuzung von *Chrysanthemum japonicum* als Mutter durch *C. morifolium*, *Decaisneanum*, oder *marginatum* gab wenige Samen, und alle umgekehrte Kreuzungen waren ganz erfolglos. Die Chromosomenzahl in der F<sub>1</sub> Nachkommenschaft ist immer grösser als die Summe der gametischen Chromosomenzahlen von beiden Eltern. Der Verf. glaubt, dass diese Chromosomenvermehrung der wiederholten Längsspaltung von *japonicum*-Chromosomen zu verdanken ist.

**306. Relationship between the age and the viability of pollen in different cucurbits.** (Japanese with English résumé). Makoto SISA. (Japan. Jour. Gen. 8, 1932, 19-25, 19 text-figs.).

In *Cucurbita moschata* which is most widely cultivated in Japan the blooming period falls in the rainy season, whence very often fruits are very poorly set out. Artificial pollination is consequently often of practical importance. For testing the pollen germination of *C. moschata* and *maxima* a 50/100 M solution of sucrose at pH 5.5, and for the same experiment of *C. Pepo* a solution similar to it but of slightly different composition was used. The experiments in the afternoon have indicated that the pollen of a flower-bud which will open the next day germinates better than that of already opened ones. Also it was observed in a certain variety that the germinating power of pollen from flower-buds increases from early morning till 9 o'clock A.M.; it begins to decrease slowly from that time to the blooming in early



morning of the following day, and then suddenly until 10 A.M. From the above indicated observation and some others it is evident that the pollination in early morning will give best results both in opened flowers as well as flower-buds.

**307. Über den Einfluss der Sonnenbeleuchtungsdauer auf das Blühen bei einigen *Quamoclit*arten.** (Japanisch). Tiharu SUDÔ. (Agric. & Hortic. **6**, 1931, 1242-1244.

Einige Arten von *Quamoclit*, wie *coccinea*, *Sloteri* usw. wurden 1. der normalen Sonnenbeleuchtung ausgesetzt, 2. von 8 Uhr Morgen bis zu 4 Uhr Abend normalbeleuchtet und dann verdunkelt, und 3. den ganzen Tag normalbeleuchtet und an der Nacht elektrisch beleuchtet. Durch diese Behandlung hat *Q. coccinea* z.B. sich als "short day plant" erwiesen: die Dauer von dem Aussäen bis zum ersten Aufblühen beträgt bei 1. 98 Tage, während bei 2. sie 27-31 Tage kürzer und bei 3. 19 Tage länger ist. In *Q. Sloteri* dagegen ist kein Unterschied in 1., 2. und 3 nachzuweisen.

**308. Florula taiheizanensis.** Sigeyosi SUZUKI. (Ann. Rpt. Taihoku Bot. Gard. **1**, 1931, 99-185).

This paper is one of the results of eager studies pursued by Japanese botanists to elucidate the Formosan flora. Taiheizan is a mountainous region in Northern Formosa of 63 177 hect. and abounding in forests of useful trees. The enumeration of plants begins with the Marattiaceae and ends with the Compositae; their number is 833 in all.

**309. An ecological study of the vegetation of Mt. Taiheizan. (A preliminary paper).** (Japanese). Sigeyosi SUZUKI. (Sylvia **3**, 1923, 1-14, 4 pls.).

After a short introduction the author describes the climate of Mt. Taiheizan and the results of a statistical study of plants collected there. As to the physiognomy of forest trees in this mountain he distinguishes the following plant-associations, viz. Lauraceae-Fagaceae Ass. (1000-1500 m. above sea level), *Cunninghamia-Konishii* Ass. (2000 m), *Chamaecyparis* Ass. (1500-2400 m), and *Tsuga-chinensis* Ass. (2000-2200 m). Besides the author has found the *Miscanthus-japonicus*, the *Picea-morisonicola*, and the *Alnus-formosana* Associations. Finally he discusses about certain important trees and forests which might be ranked among the natural monuments.

**310. Spicilegium pteridographiae Asiae Orientalis II-III.** (With Japanese résumé). Motozi TAGAWA. (Acta Phytotax. et Geob. **1**, 1932, 156-163, 306-313).

In this enumeration of plants *Dryopteris Hayatai*, *D. subaurita*, *D. purpurella*, *D. tenuissima*, *Cornopteris Tashiroi*, *Adiantum coreanum*, *Asplenium Kobayashii* are new species and described.

**311. A short report on the vegetation of the Kudju mountain ranges.** (Japanese). Makoto TAKENOCHI. (Jour. Dendrol. Soc. **14**, 1932, 632-640, 4 text-figs.)

The "Kudju" mountain ranges which form the backbone of the Kyûsyû Island are composed of a number of mountains, of which Mt. Kudju attains 1877 m above



sea level. In the whole mountain range the development of trees is not good, and the greater part is covered with herbaceous plants, which is due first of all to the volcanic activity there.

**312. On a new variety of *Viola xanthopetala* Nakai.** (Japanese with English résumé). Makoto TAKENOCHI. (Bot. Mag. Tôkyô **46**, 1932, 587). Discovery of a new variety of *Viola xanthopetala* characterized by its deeply laciniate leaves.

**313. Observation on the teratological flowers and bracts of *Viola obtusa* MAKINO.** (Japanese). Makoto TAKENOCHI. (Bot. Mag. Tôkyô **46**, 1932, 588-592, 2 text-figs.).

In a certain locality in Kyûsyû (Southern Japan) the author has found within 100 m<sup>2</sup> 100 stocks of *Viola obtusa* with normal flowers (flower number 183 in all), and 63 exclusively with abnormal ones (107 in all). The abnormality of flowers occurs in sepals, petals, stamens and pistils, and is accompanied by that of bracts which become much larger than normal and prominently laciniate. The sepals are mostly leaf-like, but sometimes become wholly or partially petaloid. The disappearance of certain sepals was sometimes observed, and the presence of two, three or more petals with the spur in one flower was also found. Besides the foliar transformation of stamens, the fusion of two stamens, etc., etc. were also met with.

**314. The inheritance of some lax varieties in rice.** (Japanese with English résumé). Yosinori TAKEZAKI. (Japan. Jour. Gen. **8**, 1932, 49-63, 1 text-fig.).

The author distinguishes four types according to the number of spikelets (or grains) per 1 cm length of panicle, viz. 4,81 (I) (normal), 2,19 (II), 1,43 (III), and 0,18 (IV). The results of several crossing experiments have shown that we are dealing here with two allelomorphic pairs  $K_a$  and  $K_b$ , so that we have type I (normal)  $K_a K_a K_b K_b$ , type II  $K_a K_a k_b k_b$ , type III  $k_a k_a K_b K_b$ , and type IV  $k_a k_a k_b k_b$ . Each of three former types was found in the author's collection of rice races, but the type IV was first produced after the crossing I  $\times$  II, and was found to breed true ever since.

**315. On the DAVIS' catalase-method modified for prophesying the germinating power of seeds.** (Japanese with English résumé). Yosisuke TAKIGUCHI. (Bul. Sc. Fak. Terk., Kjuû Imp. Univ. **5**, 1932, 103-105).

Seeds of rice, barley, wheat, *Setaria italica*, *Brassica Napellus*, etc. preserved in the air-tight glass bottles during a number of years were examined from time to time in respect to their catalase activity by gasometric method. Seeds were tested both in dry state as well as after having been soaked for 12 hrs. in hot water 32°C. The activity of catalase was represented by the volume of O liberated from H<sub>2</sub>O<sub>2</sub> during 10 min. According to the results of these studies the catalase activity of seeds soaked in water decreases very rapidly in non-viable ones, whilst in viable ones it does not or even increases, i.e. we have

$$\frac{\text{catalase in soaked seeds}}{\text{dry}} = 1 \text{ or } > 1.$$

Entries 312-315

**316. Zur Theorie des respiratorischen Quotienten nebst einer Bemerkung über den Einfluss der oxydoreduktiven Zellvorgänge auf den Gaswechsel der Zellen. Beiträge zur Atmungsphysiologie der Schimmelpilze. I.** Hiroshi TAMIYA. (Acta Phytochimica, 6, 1932, 227–263).

Im Verfolge der früher publizierten Arbeit: „Über die Verwendbarkeit von verschiedenen Kohlenstoffverbindungen im Bau- und Betriebsstoffwechsel der Schimmelpilze“ hat der Verfasser festgestellt, dass der Respirationsquotient (RQ) bei der Atmung von *Aspergillus oryzae* je nach den Arten der jeweils dargereichten C-Quelle grösser oder kleiner ausfällt als der theoretische  $\text{CO}_2/\text{O}_2$ -Wert (Verbrennungsquotient: CQ) bei der totalen Verbrennung der betreffenden C-Verbindung. So war der RQ-Wert bei Zugabe der C-Quellen, deren CQ-Wert grösser als etwa 0.875 ist (Hyperquotient), überhaupt grösser als der CQ-Wert, während bei den C-Quellen, deren CQ-Wert kleiner als 0.875 ist (Hypoquotient), das umgekehrte Sachverhältnis beobachtet wurde.

Um diese Erscheinung zu erklären, hat der Verfasser zunächst die Annahme gemacht, dass in physiologischen Reaktionssystemen—wenigstens bei solchen typischen Aerobien wie Schimmelpilzen—alle Oxydationsvorgänge letzten Endes durch überschüssige Aufnahme des molekularen Sauerstoffs vom Aussenmedium stattfinden, während alle Reduktionsvorgänge, sei es direkt oder indirekt, die überschüssige Abgabe der Kohlensäure in Aussenmedium mit sich führen.

Gestützt auf die Angaben von anderen Forschern hat andererseits der Verfasser für die Pilzkörpersubstanz als Ganzes folgende Verhältnisformel angenommen:



Unter Anwendung dieser Formel wurde die auf die Bildung von einer bestimmten Pilzmenge zu beziehende  $\text{O}_2$ -Aufnahme (bei den C-Quellen mit Hypoquotienten) bzw.  $\text{CO}_2$ -Abgabe (bei den C-Quellen mit Hyperquotienten) theoretisch ausgerechnet. Mit diesen Werten sowie auch den experimentell ermittelten Wachstums- und Atmungsgrössen wurde der RQ-Wert theoretisch vorausberechnet, die zwar mit dem experimentell gefundenen vorzüglich übereinstimmte. Es gelang somit dem Verfasser, die oben erwähnte regelmässige Abweichung des RQ-Wertes von dem CQ-Wert als Folge des Eingreifens des Aufbaustoffwechsels befriedigend zu erklären. Verf.

**317. Zur Energetik des Wachstums. Beiträge zur Atmungsphysiologie der Schimmelpilze. II.** Hiroshi TAMIYA. (Acta Phytochimica, 6, 1932, 265–304.)

Gestützt auf die Ergebnisse der vorangehend referierten Arbeit hat der Verfasser einen Weg eingeschlagen, die Stoff- und der Energiebilanz bei der Bildung des Pilzkörpers aus verschiedenen C-Quellen indirekt festzustellen. Zugleich wurde es darauf hingewiesen, dass der stoffliche sowie der energetische Wirkungsgrad des Wachstumsvorgangs indirekt durch Feststellung der Wachstums- und der Atmungsgrösse ausgerechnet werden kann, und zwar ohne dass man dafür die Menge der insgesamt verbrauchten Energie oder der C-Quelle festzustellen hat. Um die Beziehung zwischen der Wachstumsgrösse und der Atmungsgrösse zahlenmässig auszudrücken, wurden folgende Quotienten berechnet:

$$\begin{aligned} \text{Aufbauquotient} &= \frac{\text{Die Menge des gebildeten Pilzkörpers in g}}{\text{Die Menge der veratmeten C-Quelle in g}} \\ \text{Trophischer Wärmekoeffizient} &= \frac{\text{Kaloriengehalt (kcal.) von 1 g C-Quelle}}{\text{Aufbauquotient}} \end{aligned}$$

Der letztere Koeffizient stellt die Menge der Wärme, welche bei Bildung von 1 g Pilzkörper durch  $O_2$ -Atmung freigesetzt wird, in kcal. dar. Der Vergleich der theoretisch ausgerechneten Kalorienwerte der C-Quellen, die bei Bildung des Pilzkörpers als Baustein gebraucht werden sollen, mit dem von verschiedenen Autoren ermittelten Wärmegehalt des Pilzkörpers führte zu einem wichtigen Schluss, dass nämlich der Vorgang des Pilzkörperaufbaues als Ganzes bei allen untersuchten C-Quellen (47 Arten) stets eine exotherme Reaktion darstellt. Von grosser Bedeutung ist es, dass trotz der exothermen Natur der Aufbauvorgänge die  $O_2$ -Atmung immer einen unbedingt notwendigen Faktor für die Aufbauvorgänge ist. In näheren Ausführungen wendete sich der Verfasser gegen die bisher ganz allgemein herrschende Anschauung, dass verschiedene Biosynthesen und auch die Wachstumsvorgänge an und für sich immer endotherme Reaktionen darstellen sollten, und zwar dass die Atmungsenergie bei solchen synthetischen Vorgängen stets nur zur Deckung des Wärmedefizits im thermodynamischen Sinne verbraucht werde. Die Atmungsenergie soll nach dem Verfasser in der Hauptsache zur Aktivierung der Moleküle der als Baustein dienenden Substrate oder deren Derivate im Sinne der Reaktionsbeschleunigung bei synthetischen Vorgängen dienen, also eine Deutung, die gegenüber der bisherigen Theorie die kardinale Rolle der Atmungsenergie bei der Biosynthese vom Standpunkt der chemischen Kinetik aus in Vordergrund des Interesses rückt. Verf.

**318. A monograph of the Satsuma orange with special reference to the occurrence of new varieties through bud variation.** Tyôzaburô TANAKA. (Mem. Fac. Sc. & Agric., Taihoku Imp. Univ., 4, 1932, VII+626, 53 pls.).

It is hardly possible within a short space available for the reviewer to sketch out even the outline of this big monograph, so that those interested in the subject should study the original. Some references will be made below however in a few words. The mother form, from which the Satsuma orange takes its origin, came from China, and the earliest historical record of its cultivation dates back to about 300 years ago, though probably it was known from still earlier time. Its correct name is *Citrus Unshiu* MARCOVITCH. In this monograph the author describes the results of his studies pursued during a number of years concerning various types of the Satsuma orange, comparative, historical as well as experimental.

**319. Florula of the Island of Kaibatô (Todomoshiri).** Misao TATEWAKI and Ujimoto KIMOTO. (Acta Phytotax. et Geob.) 1, 1932, 234-252, 2 figs.).

Kaibatô is a small island lying west of Southern Saghalien. The plants enumerated are 122 in all, which belong to the Ferns and the Monocotyledons. The enumeration will be continued.

**320. Konstante amphidiploide Brassico-Raphanus Bastarde.** Yasufusa TERASAWA. (Proc. Imp. Acad. 8, 1932, 312-314, 3 Textabb.).

Vgl. Japan. Jour. Bot. 5, (55), Nr. 189. Statt des Wortes "tetraploid" benutzt der Verf. jetzt das Wort "amphidiploid", insofern als der Bastard im diploiden Zustande  $38 (= 2 \times 10 + 2 \times 9)$  Chromosomen enthält.



**321. Cupuliferae novae koreanae.** H. UYEKI. (Acta Phytotax. et Geob. 1, 1932, 253-256, 1 Taf.).

Die folgenden neuen Arten, Varietäten und Formen von *Quercus* in Korea sind beschrieben: *Q. serratioides*, *alienoides*, *paucilepis*, *pongtungensis*, *pseudodentata*, *aliena* var. *acuticarpa*, forma *monstrosa*, var. *heterophylla*, *mongolica* var. *dolichophylla*, *serrata* var. *longicarpa*.

**322. Mikrurgische Untersuchungen lebender Zellen in der Teilung I. Die Bildung von Tetraploidkernen, zweikernigen Zellen und anderen abnormen Teilungsbildern.** Bungo WADA. (Cytologia 4, 1932, 114-134, 2 Taf. und 6 Textabb.).

Die Resultate der Verfs. Untersuchungen über lebende Zellen der Staubfadenhaare von *Tradescantia reflexa* mittelst des Mikromanipulators sind wie folgt.

Der Kolloidzustand des Kernes verändert sich im Laufe der Teilung, wobei der Verf. drei verschiedene Stadien unterscheiden kann. In der Prophase ist durch den Anstich mittelst der feinen Mikronadeln die weitere Teilungsvorgänge leicht zur Sistierung zu bringen und zum Ruhezustande zurückkehren zu lassen, was der Verf. Rückkehrphase nennt. In der Metaxinese sowie in den noch späteren Teilungsstadien ist kein Rückkehr mehr möglich. Durch das Herausziehen des Zytoplasmas an die Äquatorialgegend in der spätern Anaphase sowie in der früheren Telophase kann man die Tochterkernanlagen an den beiden Spindelpolen mechanisch miteinander zur Berührung kommen lassen. Dann sieht man die Entstehung, entweder eines Tetraploidkernes oder einer zweikernigen Zelle, je nachdem das Plasma um die Spindel noch quellbar ist oder nicht mehr (Quellungsphase bzw. Nichtquellungsphase). Im letztern Falle entsteht bisweilen ein teilweise verschmolzenes amitoseähnliches Kernbild. Bei der spätern Anaphase wird eine schief liegende Scheidewand durch die Verlegung der Zytoplasmaanhäufung an der Äquatorialebene hervorgerufen.

**323. Über die Beeinflussung der Atmung von einigen grünen Algen durch Kaliumcyanid und Methylenblau.** (Beiträge zur Stoffwechselphysiologie der Algen. I.) Atsushi WATANABE. (Acta Phytoch., 6, 1932, 315-335).

Der Verf. hat die Beeinflussung der Atmung von einigen grünen Algen: *Chlorella*, *Ulva* und *Enteromorpha* durch Kaliumcyanid, Methylenblau, Thionin und Indigocarmin untersucht. Die autotrophe Atmung von *Chlorella ellipsoidea* in mineralischer Lösung wird durch Zugabe von 1/2000 Mol. Methylenblau am stärksten (um 150%) gesteigert und wird durch gleichzeitige Zugabe von Cyankalium noch weiter gesteigert, obwohl sich die Wirkungen von beiden Agenzien dabei nicht ganz additiv verhalten. Die heterotrophe Atmung bei Zugabe von 1-proz. Glucose wird durch 1/2000 Mol. Cyankalium stark vermindert, während die dabei persistierende autotrophe Grundatmung durch Cyankalium erhöht wird. Thionin bewirkt die Beschleunigung der Atmung, aber in geringerem Grade als Methylenblau. Auch bei *Ulva* und *Enteromorpha* wird die Atmung durch Methylenblau beschleunigt. Die Beschleunigung der Atmung ist am grössten bei *Ulva Lactuca* und *Ulva conglobata* mit 1/5000 Mol. Methylenblau; der Höchstwert der Methylenblauwirkung betrug bei *Ulva Lactuca* nur 1/3-1/5 von dem bei *Chlorella*, kam aber bei *U. conglobata* und *Enteromorpha Linza* dem bei der letzteren fast gleich. Die Atmung von *Ulva Lactuca* wird durch 1-proz. Glucosezusatz gar nicht gesteigert, aber bei *Enteromorpha Linza*



dadurch etwas befördert. Durch Thionin wird die Atmung von *Ulva Lactuca* etwa doppelt so stark wie durch Methylenblau beschleunigt, während Indigodisulfonat gar keinen Einfluss auf die Atmung ausübt.

Aus diesen Versuchen hat der Verf. die Schlussfolgerungen gemacht, dass die zweierlei Arten der Sauerstoffatmung, die nebeneinander in Algenzellen vor sich gehen können, vorhanden sind: die erste Art ist die Veratmung des Zuckers, welche durch Blausäure weitgehend hemmbar ist, aber durch Methylenblau nicht besonders deutlich aktivierbar, und die zweite Art der Atmung, die bei *Chlorella* wohl ihre ganze autotrophe Atmung ausmacht, wird durch Blausäure nicht beschädigt, sondern bei *Chlorella* sogar verstärkt, und durch Methylenblau deutlich aktiviert. Verf.

**324. Notes on some Japanese algae IV.** Yukio YAMADA. (Jour. Fac. Sc., Hokkaidô Imp. Univ. Ser. V, 2, 1932, 267-276, 7 pls. and 4 text-figs.).

The following new species are described with illustrations among others: *Avrainvillea riukinensis*, *Leathesia sphaerocephala*, *Callithamnion callophyllidicola*, *Callophyllis adhaerens*.

**325. Über den isoelektrischen Punkt der Bakteriensuspensionen.** Gihei YAMAHA. (Bot. Mag. Tôkyô 46, 1932, 423-425).

Dank den Versuchsergebnissen verschiedener Forscher ist es bekannt, dass der pH-Wert, wobei das Flockungsmaximum der Bakteriensuspensionen stattfindet, dem isoelektrischen Punkt entspricht. Der letztere ist natürlich für verschiedenen Bakterienarten verschieden. Der Verf. hebt in diesem Aufsatz eine Anzahl solcher dem respektiven isoelektrischen Punkt entsprechenden pH-Werte, welche er den früher im Prof. VLÈS' Institut zu Strassburg und auch neuerdings in seinem eigenen Institut gemachten Untersuchungen verdanken, hervor. Einige Beispiele davon: *Micrococcus ochraceus* 2,0, *Bacillus coli* 2,2-2,6, *Sarcina flava* 5,5 usw. usw.

**326. Über den isoelektrischen Punkt des pflanzlichen Zellkernes.** Gihei YAMAHA. (Proc. Imp. Acad. 8, 1932, 315-317).

Der Verf. hat an den im Wasser schwebenden Tapetenzellen aus dem Antherengewebe von *Lilium tigrinum* die Kataphoresisversuche ausgeführt. Die isolierten im Phosphat- oder Azetatgemisch liegenden, welche der elektrischen Stromspannung von 50 Volt ausgesetzt sind, wandern zur Kathode oder Anode bei pH 3,0-3,5 bzw. 4,0-4,2, und dazwischen findet keine Wanderung statt, sodass dieser Umschlagspunkt als der isoelektrische Punkt zu deuten ist. Bei den Tapetenzellkernen von *Tradescantia* hat der Verf. mittels der gleichartigen Methode wie oben beobachtet, dass das Karyotin in dest. H<sub>2</sub>O und verdünnter NaCl Lösung negativ, und in konzentrierter positiv geladen ist. Weiter zeigte der Vitalfärbungsversuch mit Bromkresolgrün den pH-Wert des Karyotins 4,6-4,8 und derselben des Nukleolus > 5,0 zu sein.

**327. On chromosome number in some Solanaceae.** Kengo YAMAMOTO and Kan-ichi SAKAI. (Japan. Jour. Gen. 8, 1932, 27-33, 36 figs.).

The chromosome number of several varieties of *Capsicum annuum*, several species of *Datura*, some species of *Physalis* and some varieties of *P. Alkekengi* was determined. In all cases  $n = 12$  and  $2n = 24$ , except *Physalis angustata* with  $n = 24$ .

**328. Observationes ad floram formosanum III, IV, V.** (With Japanese résumé). Yoshimatsu YAMAMOTO. (Jour. Trop. Agric. **4**, 1932, 187-190, 1 fig.-group; 305-307, 484-487, 1 fig.).

Among the plants enumerated the following are new species: *Goodyera seiko-montana*, *G. daibuzanensis*, *Calanthe Yushuni*, *Ranunculus taizanensis*, *Plantago major* var. *Kimurae*, *Piper kotoense*, *Adenophora Uehatae*, *Sedum cryptomerioides*, *Ilex euryaefolia*, *I. uraiensis*.

**329. Contributiones ad floram formosanum IV.** Yoshimatsu YAMAMOTO. (Trans. Nat. Hist. Soc. Formosa **22**, 1932, 408-410, 1 fig.).

In this paper besides a new var. and a new com. a new species *Oenanthe Kudoi* SUZUKI et YAMAMOTO is described with 1 figure.

**330. Physiological reseaches on the fertility in *Petunia violacea*. X. On the relation between the self-compatibility and the tissue-juice of the ovary.** (Japanese with English résumé). Sadao YASUDA. (Bot. Mag. Tôkyô **46**, 1932, 510-517).

The experiments were performed for determining the exact locality where the inhibiting substance of self-sterile *Petunia violacea* is produced. It is to be remarked that it was established formerly by the author that this substance is mainly produced in the ovary. The author has used 20% cane-sugar with little citric acid (pH = 5.7-5.8). To this was added, firstly, the tissue juice of the ovary wall, secondly, some ovules, and thirdly, the tissue juice of placenta. The pollen germination and the pollen tube growth of some incompatible individuals in such solutions were observed, and the result was that these processes were inhibited wholly in the third solution and somewhat in the second. The inhibition did not take place at all even in the second solution when the ovules were at first washed with water and then put in it. The placenta is consequently considered to be the place wherefrom the inhibitory substance is secreted. The solution wherein the placenta taken from a plant of another line was put seems to be unable to inhibit the two processes under question.

**331. Physiological researches in the fertility in *Petunia violacea* XI. On the effect of temperature upon self-fertilization.** (Japanese with English résumé). Sadao YASUDA. (Bot. Mag. Tôkyô **46**, 1932, 679-689).

Owing to repeated experiments it was observed that in general cool weather is more favourable than hot towards the occurrence of self-fertilization in *Petunia violacea*. The comparative examination of the pollen germination in the sugar solution containing the tissue juice of the style of the plant belonging to the same line as the pollen-giving one, and that of the velocity of the pollen tube growth under hot as well as cold conditions were done. It was seen that both processes are inhibited more strikingly under the former condition than under the latter. The inhibiting substance may be considered to be produced more abundantly under hot than cold condition, whence the better results of self-fertilization under cool weather.

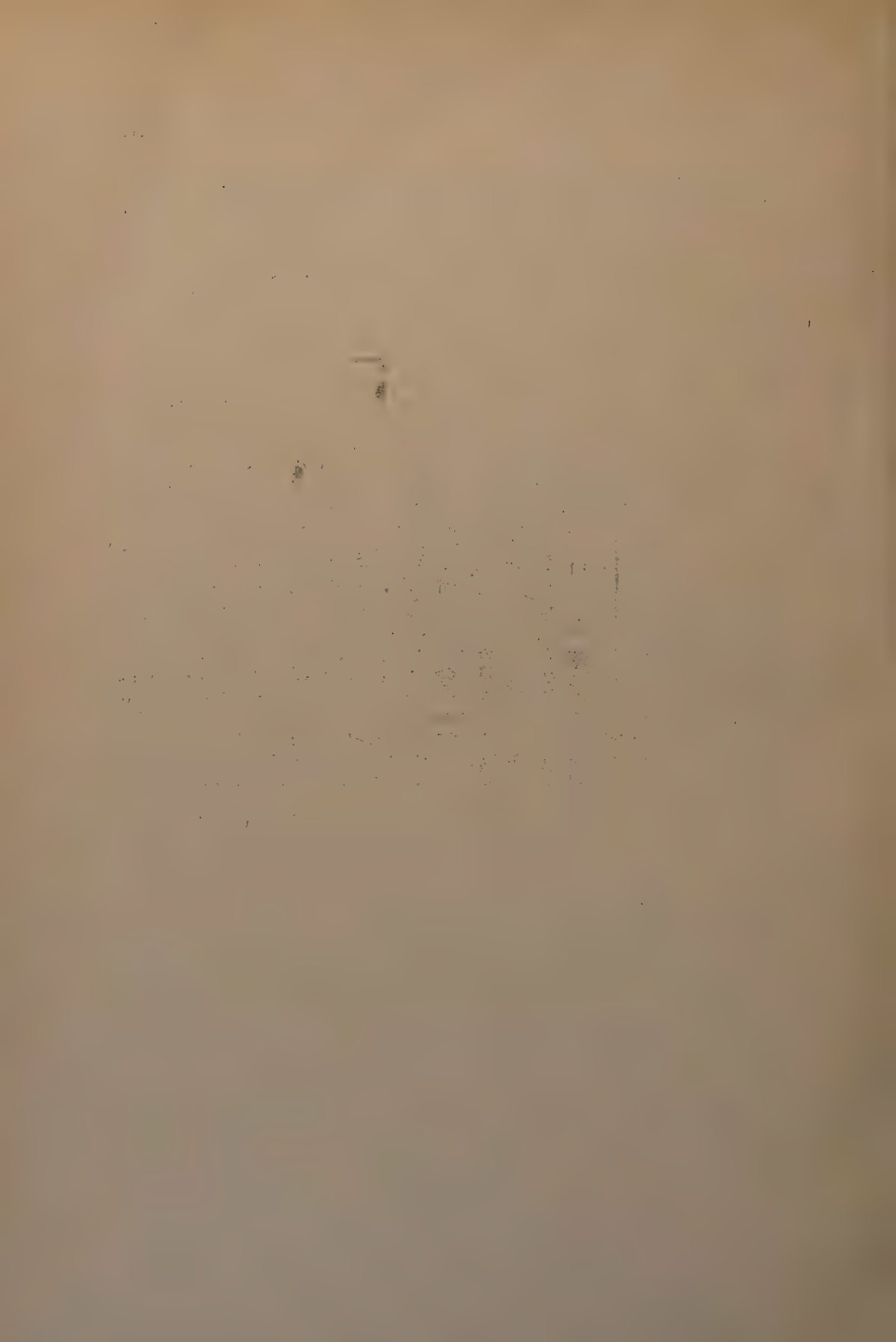
**332. On a new species of the fungus parasitic on mulberry.** (Japanese). Yasutaro YENDO and Kiiti TAKASE. (The Alumini Assoc. Uyeda Coll. Seric. and Silk-Indust. **4**, 1932, 111-113, 4 text-figs.).

A new fungus was found which is parasitic on leaves of mulberry-trees. Its mycelium runs over their surface, and produces pycnidia in form of small black spots. No considerable damage ensues. It is named *Coniothyria mori* sp. nov.

**333. On the root-tubercles of *Elaeagnus*.** (Japanese). Yasutaro YENDO and Kiiti TAKASE. (The Alumini Assoc. Uyeda Coll. Seric. and Silk-Indust. **4**, 1932, 114-130, 2 pls. and 3 text-figs.).

In the root-tubercles of *Elaeagnus* (esp. *E. multiflora*) a Myxomycete is found in its cortical cells, causing their aggrandisement and various modifications in form and size of their nuclei. Neither filiform fungi nor *Actinomyces* species nor other bacteria were seen which may be considered to be the causal organisms of the tubercular formation. The authors could distinguish three stages of the development of the Myxomycete above indicated. In the stage called *vegetative plasmodia* by the authors the plasmodia are colourless, semi-transparent, sometimes fibrillar and the nuclei are not recognizable even by staining. These plasmodia seem to be able to pass from one cell to another. The second stage is called *yellowish-brown plasmodia* which live in other cells than those where the plasmodia in their first stage above mentioned were found. They are dense in their consistence and do not stain easily; nuclei are invisible even after staining. In the third stage which the authors call *aggregated plasmodia* (?) the latter fill up large cortical cells and consist of homogeneous globular granules, where the nuclei and the minute chromatin grains are easily recognizable by staining. This latter stage may be considered to be a transition from the vegetative to the reproductive phase. The meiosis occurs there before the spore-formation, the chromosome number being  $n = 6$ ,  $2n = 12$ . The spore formation takes place owing to the direct division of spore mother-cells which give rise to tetrads. Spores germinate under water to form germ-tubes; they become gradually amoeboid but never take the form of swarmspores. The germination takes place between pH 6-7 in saccharose solution. In the tubercles starch, fatty oils, invert sugar, and albumincas substances are pretty abundant. The ferments are chiefly pepsin, tyrosinase, peroxydase, and catalase.

The Myxomycete under question is considered to be a new species, *Tetramyxa Elaegni*.





## Abstracts Nos. 334-439

(Referring to the principal papers in Botany and allied subjects which have appeared in Japan during January-June 1933)

**334. On the relation of air humidity to germination and the effect of low temperature on the vitality of urediniospores of some species of cereal rusts.** (Japanese with English résumé). TAKUJI ABE. (Ann. Phytopath. Soc. Japan **2**, 1933, 501-512).

Experiments were done on *Puccinia glumarum*, *P. triticina* and *P. Lolii*. In *P. triticina* either the water-saturated atmosphere or a drop of precipitated moisture is the best condition for the germination of its urediniospores, while under the relative humidity of 99% only 4.25% spores will germinate; under 95% the occurrence of germination is doubtful. In *P. glumarum* the germination of spores even in water-saturated atmosphere was found to be lower than in those covered with a film of water. In *P. Lolii* the germination of spores in water-saturated atmosphere is not very low, as compared with that in water-drop.

In *P. triticina* and *Lolii* the spores placed under -8 - -9° did not lose their vitality during 44 days. In the spores of *P. Lolii* frozen for 24 hours their germinating power was decreased to ca. 4%.

**335. Untersuchungen über die Chromosomenzahlen bei den asiatischen Pyrusarten.** SYÔZÔ ADATI. (Cytologia **4**, 1933, 182-188, 12 Textabb.).

Der Verf. hat die Reifungsteilung der Pollenmutterzellen einer Anzahl von *Pyrus*arten studiert, besonders bei der ersten Metaphase, und immer 17 Bivalente gefunden. In Bezug auf die Genomkonstitution der Pomoideen sind sie nach DARLINGTON dreifach hexasomische Tetraploide mit der Grundzahl 7, während nach SAX sie als aus der Bastardierung von 9- und 8-chromosomigen Arten entstandene Allopolyploide aufzufassen sind. Die Resultate seiner Beobachtungen führten den Verf. zur Bestätigung der SAXschen Ansicht: er konnte häufig dicht beieinander liegende Chromosomenpaare beobachten, aber niemals die Verbindung derselben zu Komplexen.

**336. On the systematic anatomy of the leaves of some Japanese carices (I).** (Japanese) SHIGEO AKIYAMA. (Bot. Mag. Tôkyô **47**, 1933, 446-460, 532-550, 17 text-figs.).

The surface view of various kinds of epidermal cell-strands, coupled with the observation of sections of leaves will give the distinguishing marks of various species of Japanese *Carex* species. In this first report 17 species are treated of. An artificial key for the species determination according to such characteristics is followed by the special part, which forms the chief bulk of the paper where the anatomical description of each species is given in detail.

**337. Über eine neue Krankheit von *Aesculus turbinata*.** (Japanisch). TOSIO EGAMI. (Jour. Plant Prot. **18**, 1931, 723-727).

Der Erreger der Krankheit ist eine neue Art *Septocylindricum aesculi* TOGASHI et EGAMI.

**338. Verbreitung der schwefeloxydierenden Bakterien in den Thermen Japans.** Yoshikadzu EMOTO. (Bot. Mag. Tôkyô 47, 1933, 6-29).

Dank der eifrigen Studien verschiedener Forscher sind viele schwefeloxydierende Bakterien, welche in den in Japan reichlich vorhandenen Thermen bewohnen, bekannt geworden. In Bezug auf ungefähr 50 in verschiedenen Gegenden Japans befindlichen Thermen hat der Verf. die dort bewohnenden Bakterien isoliert, die Temperatur und die H-Ionen-Konzentration bestimmt. Die Ergebnisse seiner Studien wird tabellarisch am Ende des Aufsatzes zusammengestellt.

**339. Myxomyceten aus Mexiko.** Yoshikadzu EMOTO. (Bot. Mag. Tôkyô 47, 1933, 132-135).

Etwa 30 Arten, welche zu 14 Gattungen gehören, sind angegeben.

**340. Myxomyceten der Südmandschurei. 2. Mitteilung.** Yoshikadzu EMOTO. (Bot. Mag. Tôkyô 47, 1933, 200-202).

26 Arten sind angegeben, von denen 9 zu *Physarum* gehören.

**341. Die Mikroorganismen der Thermen. Eine historische Uebersicht über die Erforschung der Thermalorganismen.** Yoshikadzu EMOTO. (Bot. Mag. Tôkyô 47, 1933, 268-295).

Die historische Uebersicht beginnt mit den Untersuchungen SCHWABES über die Mikroorganismen in Karlsbad im J. 1837 und endet mit denselben von SPRENGER über die Diatomeen aus den Thermen von Karlsbad im J. 1930. Jede Untersuchung wird kurz geschrieben. Die Literarurliste enthält im ganzen 188 Arbeiten.

**342. Studien über die Myxomyceten in Japan.** Yoshikadzu EMOTO. (Bot. Mag. Tôkyô 47, 1933, 371-383).

In diesem Aufsatze wird eine kurze Geschichte der Myxomycetenforschungen in Japan skizziert. Die allererste Forschung ist die im J. 1888 erschienene Arbeit von N. TANAKA über die Entwicklung einer Art *Physarum*. Die nachfolgenden Forschungen über die Systematik, Physiologie usw., welche in Japan erschienen sind, sind einzeln erläutert. In der Literaturliste sind im ganzen 72 Arbeiten (1888-1932) erwähnt.

**343. On some properties of the tobacco mosaic virus.** Teikichi FUKUSHI. (Japan. Jour. Bot. 6, 1933, 381-392).

**344. Studien über eine neue *Rhodospirillum*art aus Yumoto bei Nikko.** Takeo HAMA. (Jour. Sc. Hiroshima Univ. Sec. B, Div. 2, 1, 1933, 135-153, 1 Taf. u. 4 Textabb.).

*Rhodospirillum longum* HAMA sp. nov., eine in den Thermen von Nikko befindliche Art, c. 7-250  $\mu$  lang und 1-1,2  $\mu$  dick, ist an beiden Enden je mit einem Geisselzopf versehen, flexibel bei langen Individuen, zeigt die sog. Plasmaanschwellung

oder kurze Zweige, und enthält das Volutin. Die Querteilung geht sehr schnell vor sich; ihre Zelle kann plasmolysiert werden. Die GRAMfärbung ist fast immer negativ. Verschiedene Nährflüssigkeiten wurden für die Züchtung angewendet, wenngleich keine reine Kultur gelungen ist. Optimum Temperatur für das Wachstum ca. 26°C.

**345. Nine species belonging to the order Thiobacteriales BUCHANAN, found in Hiroshima.** Takeo HAMA. (Jour. Sc. Hiroshima Univ. Ser. B, Div. 2, 1, 1933, 157-163, 3 pls., 2 text-figs.).

2 species of *Thiospirillum*, 3 of *Chromatium*, 1 of *Thiospira*, 1 of *Rhodospirillum*, and 2 of *Beggiatoa* are enumerated, of which many are new and described. The habits of the aforementioned species and the kinds of culture media are also described.

**346. La systématique des plantes. Tome I. Les gymnospermes.** (En japonais). Bunzô HAYATA. 886 pages, in-4°, éd. Utida Rôkakuen, Tokio, 1933. Prix : 15 yen.

L'auteur se propose de donner, en cinq volumes intitulés "La Systématique des Plantes," le résumé de plus de six ans de ses études et travaux. Professant l'opinion qu'en systématique l'ordre de la description n'entre pas en ligne de compte, il vient de publier comme premier volume "Les Gymnospermes." Pour le bien des lecteurs, l'auteur suit le système le plus généralement admis, celui d'ENGLER. Après une explication générale des spermatophytes et des gymnospermes, il décrit les sept classes aujourd'hui admises, depuis les Cycadofilicinées jusqu'aux Gnétinées. Il expose leurs caractéristiques, leur classification, leurs relations, leur distribution géographique, etc. Il donne également la description des familles, ordres et genres et ajoute une clef dichotomique concernant les espèces indigènes au Japon. Enfin à la fin du volume, se trouve un chapitre sur "l'écologie et la distribution géographique des gymnospermes au cours des âges géologiques."

La description des caractères, des relations mutuelles, de l'état de développement, et de la distribution de ces gymnospermes, au point de vue de la systématique, dans le passé et le présent est présentée comme un fait tel qu'il est. Dans cet ouvrage, l'auteur donne non seulement une description détaillée des fleurs, mais encore il fournit aux lecteurs l'exposé des connaissances les plus nouvellement acquises en systématique. L'auteur s'est, en particulier, spécialement attaché à la comparaison minutieuse des gamétophytes de chaque ordre, considérant tout aussi bien le processus de la fécondation, que la naissance de l'embryon et le développement de l'organe végétatif, à l'égard duquel la dissection de la stèle a été poussée très avant. Mais ce volume n'est pas seulement un ouvrage descriptif complet des gymnospermes, il développe encore la théorie de l'auteur sur le problème de la systématique. On la trouve surtout exposée dans le premier chapitre: "Qu'est-ce que la systématique?," dans la conclusion, et dans le supplément résumant la note suivante publiée, en 1931, dans les Comptes rendus des séances de l'Académie des Sciences de Paris: "Le système dynamique des plantes fondé sur la théorie de la participation."

Pour bien comprendre la classification naturelle, il est nécessaire de considérer tous les systèmes de classification possibles et de s'appuyer sur leur synthèse. Les plantes ne présentent pas les seules relations d'un arbre phylogénétique, mais des



relations beaucoup plus compliquées, à la fois verticales et transversales, comme les mailles d'un filet. On peut considérer ces relations de points de vue divers. La relation phylogénétique (d'une espèce à une autre), apparente dans une espèce, est limitée à un domaine extrêmement étroit. Par conséquent, la systématique ne peut se baser sur une relation phylogénétique tellement limitée. Se fondant sur un tel raisonnement, l'auteur nie formellement les systèmes phylogénétiques actuellement en vogue. Il propose et défend ce qu'il nomme "la théorie de la participation." D'après cette théorie, il attribue l'apparition d'une nouvelle espèce à la mutation ou au croisement. Il nie absolument toute relation phylogénétique entre une espèce actuelle et une autre espèce fossile. Il déclare qu'il est inutile de chercher, parmi les fossiles, les ancêtres des plantes actuelles, même en les interprétant au moyen d'une anatomie comparée très minutieuse. Dès lors la question se pose de savoir pourquoi il est impossible de trouver les ancêtres des plantes actuelles parmi ces fossiles? L'auteur explique cela par sa "théorie de la cause de la pétrification." Voici en peu de mots l'essentiel de cette théorie: quand le moment de l'extinction d'une espèce s'approche, quelque chose qui est nommé par l'auteur "pétrine" s'amorce dans cette plante. C'est cette pétrine qui devient la cause de l'extinction de cette espèce et en même temps la cause de sa conservation comme fossile. On ne peut pas trouver l'ancêtre d'une espèce actuelle parmi les fossiles, parce qu'une nouvelle espèce apparaîtrait rajeunie par mutation ou par abâtardissement. Une telle espèce ne contient pas de "pétrine" et dès lors ne peut être fossilisée. Il va de soi que cette "pétrine" est une chose encore très hypothétique.

Se basant sur sa théorie, l'auteur nie la lutte pour l'existence et soutient la continuité des espèces et la succession de la végétation. Il donne aussi une explication "dynamique" de ce problème longtemps discuté: ce que l'on nomme fleur femelle chez les conifères, est-il une fleur ou une inflorescence?

L'ouvrage clairement écrit, permettra à tous ses lecteurs de comprendre la théorie originale de l'auteur et les amènera à en donner une critique sérieuse.

Résumé par l'auteur.

**347. What is the classification?** (Japanese.) Bunzô HAYAMA. (Bot. Mag. Tôkyô 47, 1933, 461-465).

Under this title, the author expresses his opinion on the principal aims of classification. The aims are 1) to group individuals into a party or parties of higher or lower rank, i.e. species, genera, families and so forth, according to their constitutional resemblance, in examining their genes or factors and combinations of the latter, manifested in the individuals and 2) to arrange several or all of the parties in a system founded on principles which are proposed by an author.

Taking the Asclepiadaceae as an example, we first examine some characteristics in the flowers of several individuals, and if we find that they all agree so far in flower-character, as may be expressed by a formula  $K5 C(5) A5 G2$ , we group them into a family, the Asclepiadaceae, though they may differ one from another in the characters of some portions other than flowers. Consequently, speaking metaphorically, classification in the biological world is like chemistry in the inorganic world.

Why do we want to arrange all the parties of several ranks (lower or higher) in a system? This is because that in doing so we might easily understand the real state



of matters which we might have very difficult to grasp, were they not arranged in a certain system. The latter should be different, as principles are different, which are formulated in a system. The real state (natural relations) of organic beings can never be explainable by a single system. The real or natural relations could be only understandable on the basis of the synthesis (figuratively speaking) of several possible systems. Hence the dynamic system of the author (cf. No. 347, p. (98)).

He insists on his opinion on the impossibility of classifying species according to their phylogenetic relations, and also on the impossibility of finding the direct ancestors of living beings among extinct fossils. The matter concerning the latter is explained by the author by his "petrine theory" (cf. No. 347, p. (98)).

He concludes that it is the constitution of organic beings that should be considered in classification, but not phylogeny. Author.

**348. Miscellaneous notes on Japanese fungi. I.** (Japanese). Takewo HEMMI and Shizuko KURATA. (Acta phytotax. et geobot. **2**, 1933, 109-117, 4 text-figs.).

Accounts are given, sometimes with figures, in respect to *Phyllosticta castaneae*, *Venturia Kunzei*, *Clavaria corniculata*, *C. subfalcata*, *C. aurantio-cinnabarina*, *Tubercinia ranunculi*, *T. japonica*, *T. cepulae* and *T. tritici*.

**349. Additional notes on the Melampsoraceae of Hokkaido II.** Naohide HIRATSUKA. Trans. Tottori Soc. Agric. Sc. **4**, 1932, 111-115).

15 species belonging to *Thekopsora*, *Hyalospora*, *Milesina*, *Uredinopsis* and *Chrysomyxa* are enumerated.

**350. On species of the Melampsoraceae collected in Nikko and its vicinity.** (Japanese). Naohide HIRATSUKA. (Trans. Tottori Soc. Agric. Sc. **4**, 1933, 143-155).

27 species are enumerated: 3 *Melampsora*, 1 *Phakopsora*, 2 *Melampsorella*, 1 *Melamporidium*, 9 *Pucciniastrum*, 4 *Thekopsora*, 1 *Calyptospora*, 2 *Hyalospora*, 1 *Uredinopsis*, 3 *Chrysomyxa*.

**351. Studies on *Uromyces Fabae* and its related species.** Naohide HIRATSUKA. (Japan. Jour. Bot. **6**, 1933, 329-379, 2 pls.).

**352. Uredinales collected in Formosa I.** Naohide HIRATSUKA and Yoshio HASHIOKA. (Trans. Tottori Soc. Agric. Sc. **4**, 1933, 156-165).

60 species are enumerated, of which *Uromyces decoratus* SYD., *Uredo Elephanto-podis* PETCH., and *Uredo clerodendricola* P. HENN. are those which were never found in Japan and its territory till that time. 9 other species are for the first time collected in Formosa, though previously found in other parts of Japan.

**353. Nuntia ad floram japoniae XX-XXI.** (With Japanese résumé). Masaji HONDA. (Bot. Mag. Tôkyô **47**, 1933, 296-299, 321-322, 433-437, 481-482, 3 text-figs.).

The following new species are described among others: *Sanguisorba Kishinamii*, *Gentiana subpetiolata*, *Festuca Iwamotoi*, *Saxifraga Jotanii*.

**354. Studies on the Hepaticae of Japan VIII.** Yoshiwo HORIKAWA. (Jour. Sc. Hiroshima Univ. Ser. B, Div. 2, **1**, 1933, 197-205, 1 pl. and 4 text-figs.).

The following new species are described among others with figures: *Riccardia blasioides*, *R. submersa*, *Leucolejeunea planifolia*, *Lopholejeunea nipponica*, *Drepanolejeunea assymetrica*, *D. serrulata*, *D. japonica*, *Leptocolea pseudogoebelii*.

**355. On the taxonomy of nameko fungus in Japan.** (Japanese). Sanshi IMAI. (Bot. Mag. Tôkyô **47**, 1933, 384-389).

"Nameko" is the local Japanese name of an edible fungus highly appreciated in Japan, and includes at least the following six species, viz. *Collybia velutipes*, *C. Nameko*, *Pholiota adipora*, *P. mutabilis*, *Flammula lubrica* and *F. lenta*. Of these *Collybia Nameko* is the name given by T. ITO (cf. Japan. Jour. Bot. **4**, (87), No. 273). The author's examination has proven that it belongs really to the genus *Pholiota*, so that the name should be changed to *Pholiota Nameko* (T. ITO) S. ITO et IMAI.

**356. Studies on the Agaricaceae of Japan. I. Volvate agarics in Hokkaido.** (With Japanese résumé). Sanshi IMAI. (Bot. Mag. Tôkyô **47**, 1933, 475-478).

15 species of *Amanita*, 5 of *Amanitopsis*, 4 of *Volvaria* are mentioned, of which the following are new and described: *Amanita subjunquilla*, *A. sepiacea*, *A. spissacea*, *A. pulchella*, *A. flavipes*, *Amanitopsis avellaneosquamosus*, *A. clavisquamosa*.

**357. Keimentwicklung von *Pelvetia Wrightii* YENDO.** (Japanisch). Shunpei INOH. (Mitteil. aus d. Inst. f. Algenforsch. wiss. Fak. Hokkaido, kaiserl. Univ. **1**, 1933, 11-17, 2 Textabb.).

Die Fortpflanzung von *Pelvetia Wrightii* erfolgt in Juli-August. Sie ist monözisch und trägt Antheridien und Oogonien in ein und demselben Konzeptakel. Die Eizellen sind direkt im Meereswasser ausgestossen, worauf die Befruchtung stattfindet. Jedes Oogonium trägt eine einzige Eimutterzelle und 32 Chromosomen wurden während ihrer zweiten Kernteilung gezählt. Die Zentrosomen wurden in gewissen Stadien nachgewiesen. Unter acht in der Eimutterzelle entstandenen Zellkernen gehen sechs zu Grunde, womit zwei einkernige Eizellen ausgebildet sind. Jede Eizelle teilt sich zu zwei Zellen, von denen die eine sich zu den Rhizoiden entwickelt. Bei den letzteren gibt es drei Arten, nämlich vielzellige einfache Rhizoiden, dieselben mit zu verschiedenen Grade gabeliggeteilten Spitzen, und dieselben, welche gabelig geteilt sind.

**358. Primary outbreak of the important diseases of the rice-plant and common treatment for their control.** (Japanese with English résumé). Seiya ITO. (Rpt. Hokkaido Agric. Exp.-Sta. Sapporo **28**, 1933, 207+(7), 6 pls.).

Among the great number of diseases of the rice-plant affecting both the quality and the yield of the crop we may enumerate the blast disease (*Piricularia oryzae*), the sesame leaf spot disease (*Ophiobolus Miyabei*), and the bakanae (*Gibberella Fuzikuroi*), as the most serious and the most widespread ones in Japan. In this paper the author describes concerning each of these diseases the results of his experiments on the overwintering and the longevity of the causal fungus and the relation to the primary outbreak of these diseases in the next season. On account of purely descrip-

tive character of the paper it is hardly possible to make here even its short abstract, so that those interested in this subject should consult the original.

**359. Genetical and cytological studies on species hybrids in *Quamoclit*.** Fuyuwo KAGAWA and Goichi NAKAJIMA. (Japan. Jour. Bot. **6**, 1933, 315-327, 4 pls. and 14 text-figs.).

**360. On the striped flowers of *Mirabilis Jalapa*, L.** (Japanese with English résumé). Bensô KANNA. (Japan. Jour. Gen. **8**, 1933, 165-178, 1 text-fig.).

The author's studies on the genetics of flower-colour of *Mirabilis Jalapa* were done with especial reference to the striping. Two sets of multiple allelomorphs, viz. *C*, *c*, *c'* as well as *R*, *r*, *r'* are concerned, and the mutability in the striped flowers is caused by the presence of certain modifiers. Three types of bud mutations were observed, which are due to somatic mutation.

**361. Viscosity changes in the cytoplasm during mitosis as indicated by Brownian movement.** Kazuo KATÔ. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B, **8**, 1933, 201-215, 2 pls.).

The author has studied the change of viscosity in the cytoplasm during mitosis by using the Brownian movement as the indicator. In heterotype division in the pollen mother-cells of *Lilium speciosum* he observed that the viscosity is greater in diakinesis than in the preceding stages, and decreases in late metaphase and early anaphase. The behaviour in the homotype division is identical with that seen in the heterotype stage, except in the stage corresponding to diakinesis. The viscosity was found to be greatest in the neighbourhood of the nucleus and to decrease gradually towards the periphery of the cell. When some granules in the cytoplasm enter the nucleus, whose membrane was accidentally ruptured, the author could observe that this movement is more active than it had been in the cytoplasm, which shows that the viscosity is smaller in the nuclear sap than in the cytoplasm, though it remains yet undecided, whether this is natural or merely due to the rupture.

In stamen hairs of *Tradescantia reflexa* the Brownian movement is most pronounced in meta- and anaphase.

**362. Weitere Untersuchungen über die pentaploiden *Triticum-Bastarde* III.** Hitoshi KIHARA, Shunjiro WAKAKUWA und Yukio YAMAMOTO. (Japan. Jour. Bot. **6**, 1933, 411-424, 2 Textabb.).

**363. On the hydrogen-ion concentration of the solution in water-culture of flax plant.** (Japanese). Muneo KIKUCHI. (Proc. Crop Sc. Soc. Japan **5**, 1933, 163-168, 1 fig.).

The flax was considered generally to be feebly resistant against the degree of acidity. The author's experiments of water-culture has shown that it is pretty resistant in this respect, thus he found the optimum hydrogen-ion concentration to be 4.0-5.5.

**364. Über die Kätzchen von *Chosenia*.** (Japanisch). Arika KIMURA. (Pflanzen und Tiere **1**, 1933, 637-641, 6 Textabb.).



*Chosenia* ist eine von T. NAKAI neu begründete Gattung der Salicaceen, und dieser Aufsatz bezieht sich auf gewisse Beobachtungen darüber. Die weiblichen Kätzchen hängen bei der Blütezeit nach unten herab, doch nach der Befruchtung beginnen sie allmählich senkrecht zu stehen. Der Fruchtknoten, welcher zur Blütezeit in innigem Kontakt mit dem Kätzchenachse und nach unten gerichtet war, beginnt jetzt anzuschwellen, entfernt sich von demselben, und liegt senkrecht dazu, obgleich sein Stiel immer zu demselben parallel verbleibt. Dann fallen die Brakteen und die Narben ab; die letztere Tatsache ist ein der wichtigsten Gründe der Neubegründung der Gattung *Chosenia*, indem sie anderswo sehr selten zu sehen ist. Sie ist noch nicht durch viele europäischen Botaniker anerkannt, doch lässt das Vorhandensein verschiedener Eigentümlichkeiten bei derselben dem Verf. die neue Begründung dieser Gattung berechtigt erscheinen.

**365. Zur Morphologie und Biologie einer Leuchtbakterienart (*Pseudomonas phosphorescens* KISITANI).** Teidirô KISITANI. (Jour. Sc. Hiroshima Univ. Ser. B, Div. 2, 1, 183-196, 2 Taf. und 5 Textabb.).

Die vegetative Zelle von *Pseudomonas phosphorescens*, eine neue Leuchtbakterienart, ist stark pleomorph unter dem Einfluss verschiedener Salzkonzentrationen der Kulturmedien und der Lufttemperatur. Die Gonidien und die Arthrosporen sind ihre Fortpflanzungszellen. Es ist merkwürdig, dass im Laufe der Entwicklung die vegetativen Zellen in einen amorphen Zustand übergehen (Symplasma), um doch wieder zu neuen vegetativen Zellen zurückzukehren.

**366. Compositae novae japonicae IV-V.** (With Japanese résumé). Siro KITAMURA. (Acta phytotax. et geobot. 2, 1933, 37-51, 118-129).

The following new species are described: *Asteromoea Shimadai*, *Blumea oblongifolia*, *B. formosana*, *Cirsium glabratum*, *C. gratiosum*, *C. indefensum*, *C. irumtense*, *C. tristissimum*, *Erigeron Fukuyamae*, *Eupatorium yakushimaense*, *Heteropappus arenarius*, *Picris kaimaensis*, *Saussurea modesta*, *Taraxacum formosanum*, *T. elatum*, *T. pectinatum*, *T. latifolium*, *T. sachalinense*, *T. shikokianum*, *T. tokaiense*, *T. alpicola*, *T. shumushuense*, *T. Ohwianum*, *T. shikotanense*, *T. Kojimae*, *T. sachalinense*.

**367. The classification synopsis of the Mastigophora.** (Japanese). Gen'iti KOIDZUMI. (Acta phytotax. et geobot. 2, 1933, 1-13).

Among the Mastigophora (Flagellata) those showing the algal characters are called Mastigophyta or Mastigophyceae (Phycomonadidea, Monadophyceae, Phycoflagellatae, Phycmastigiina). The author's classification of the latter is as follows: Class I. Euphycoflagellata incl. 6 subclasses, viz. Chrysomonadina, Cryptomonadina, Chloromonadina, Euglenoidina, Heterochloridina, Phycomonadina. Each subclass is divided into a certain number of orders (or sometimes suborders), and each order into families.- Class II. Dinophyceae is divided into two subclasses, viz. Desmocontae (Adiniferidia) and Diniferidia, each subclass into a certain number of orders, each order into families.

The classification of the Mastigophyta according to PASCHER is appended at the end of the paper.



**368. *Taraxacum novum orientali-asiaticum* I.** Hideo KOIDZUMI. (Bot. Mag. Tôkyô **47**, 1933, 89-124).

The author thinks that the characters generally taken till now for the classification of *Taraxacum* species do not suffice for their clear distinction, and he takes the following into consideration in his new mode of classification, viz. the nature of hairs on involucre bracts, the form of hairs on corolla tubes, that of setulae on the spines or protuberances of the akenes. His enumeration contains among others 36 new species besides many new varieties and forms.

**369. Über das Erscheinen und Erbllichkeit von zwei teratologischen Reisarten.** (Japanisch). Mantarô KONDÔ und Sigeo ISSIKI. (Nôgyô Kenkyû (Landw. Studien) **20**, 1933, 135-153, 4 Taf.).

Betreffend die von den Verff. bekommenen zwei Reismutanten, welche sie sterile Reis pflanze mit gedrehten Blättern nennen, ist die eine 1. durch die Eigentümlichkeit des Blattes ausgezeichnet, welches der Mittelrippe entbehrt und am Grunde gedreht ist, 2. durch die abnormale Verzweigungsweise des Halmes, 3. durch das Vorhandensein zweimaliger Schossenperiode, und 4. durch wegen der Foliardegeneration der Karpelle verursachten völlige Sterilität. Die obigen abnormalen Charaktere sind gegenüber den normalen rezessiv und zeigen das monohybride Verhalten. Die Chimären, welche aus normalem und abnormalem Teile zusammengesetzt sind, wurden aufgefunden, und es wurde festgestellt, dass alle Körner aus dem normalen Teil sich zu den normalen Pflanzen entwickeln.

Bei der zweiten Mutante, welche die Verff. schmalblättrige offenglumige Sippe nennen, sind die Blätter schmaler als bei der normalen; die Spelzen der Karyopsen sind offen, weil sie so schwach sind, dass sie nach dem Ende der Befruchtung nicht wieder schliessen können. Die Reiskörner sind klein und missgestaltet. Die obigen abnorme Charaktere sind gegen die normalen rezessiv und zeigen das monohybride Verhalten.

**370. Über das Erscheinen und Erbllichkeit der Abnormitäten bei der Brassicazüchtung.** (Japanisch). Mantarô KONDÔ und Sigeo ISSIKI. (Nôgyô Kenkyû (Landw. Studien) **20**, 1933, 155-183, 11 Taf.).

Aus aus 33 gekauften Samen von *Brassica chinensis* hervorgegangenen Individuen sind dank der Selbstung 33 Familien angekommen, von denen 24 die Blattabnormitäten zeigten. Die Kultur solcher abnormalen Sippen wurde während sechs Jahre fortgesetzt und dank der Selbstung und Selektion wurde ihr Dasein versichert. Die Abnormitäten sind wie folgt: während das Blatt der ursprünglichen Sippe ganzrandig ist, ist das Blatt, welches mehr oder minder tief gelappt ist, entstanden, ja sogar wurde solches gesehen, wobei das sehr schmale Blattlamina bloss längs der Mittelrippe vorhanden ist. Auch wurde solches Blatt bekommen, welches am basalen Teile zwei bis vier Lappen zeigt. Diese letzte Tatsache ist der Wirkung von zweierlei polymeren Faktoren *K* und *L* zu verdanken: wenn 3-4 derselben vorhanden sind, erscheinen vier oder mehr Lappen, während bei dem Vorhandensein von bloss 1-2 derselben nur 2-3 Lappen entstehen werden. Die Abwesenheit von *K* und *L*, oder im Falle, wenn die letzteren vorhanden sind, die Wirkung des Hemmungsfaktors *I*<sub>2</sub> macht die Entwicklung von Lappen unmöglich.

**371. Studien über die Erkennung der Drogen auf Grund des Aschenbildes (IV. Mitteilung). Blattaschenbilder wichtiger Krautdrogen.** (In deutsch und japanisch). Yosio KONDO. (Jour. Phar. Soc. Japan **615**, 1933, 73-87, 505-548, 4 Taf.).

Das Material besteht aus den Blättern von 54 Arten, von denen viele zu den Kompositen und den Labiataen gehören. Die Strukturelemente der Aschenbilder sind die Kalkoxalatkrystalle (tetragonale sowie monokline Einzelkrystalle, Krystalldrüsen, Sphäriten, Krystallsandzellen), Plastiden, verkieselte Haare, Drüsenschuppen, Stomata, Aschenskelette verkieselter Epidermiszellen und Blattparenchymzellen, Cystolithen. Ein Schlüssel zur Bestimmung der untersuchten Krautdrogen nach den obenerwähnten Merkmalen ist angegeben.

**372. Die Beziehungen zwischen den verschiedenen physiologischen Erscheinungen der Pflanzen und den in verschiedenen Vegetationsorganen in Erscheinung tretenden Farbstoffen. IV. Mitteilung. Über die Beziehungen zwischen dem Dasein des Anthozyanfarbstoffes und dem Grad der Assimilationstätigkeit bei einigen Kulturpflanzen.** Hiroshi KOSAKA. (Jour. Dpt. Agric, Kyûsyû Imp. Univ. **3**, 1933, 251-267).

Gewisse Sorten von *Perilla nankinensis* und *Oryza sativa*, welche das Anthozyan in den Blättern enthalten sowie dieselben von *Abutilon avicennae*, welche es in den Blattstielen und Stengeln, doch gar kein in den Blättern enthalten, sind betreffend ihre Assimilationstätigkeit mit den Sorten gleicher Arten, welche gar kein Anthozyan enthalten, vergleicht. Die Assimilationstätigkeit wurde durch die Bestimmung der Differenz im Gesamtgehalt an Kohlehydraten der an einem hellen Tage morgens bzw. abends gepflückten Blätter gemessen. Es wurde dabei festgestellt, dass diese Tätigkeit immer grösser bei den ersteren als bei den letzteren ist, vorausgesetzt, dass die Lufttemperatur nicht zu hoch ist. Dass bei gewissen Sorten von *Abutilon* und *Datura*, welche das Anthozyan bloss in Stengeln und Blattstielen führen, die Assimilationstätigkeit grösser ist wie bei den Sorten mit nicht anthozyanführenden Blättern ist wahrscheinlich dazu zuzuschreiben, dass die Blätter kein Anthozyan, doch das Chromogen enthalten und das letztere das Assimilation aktiviert. Nur bei *Corchorus capsularis* sind die Resultate ganz denen anderer Pflanzen entgegengesetzt, indem die Assimilationstätigkeit kleiner war als bei den anthozyanführenden als bei nicht es führenden Sorten. Nach des Verfs. Ansicht dürfte es der eigentümlichen Beziehung zwischen dem Anthozyan oder Chromogen und der Temperatur bei Tropenpflanzen, wie *Corchorus*, zurückzuführen sein, welche etwas anders ist bei ihnen als bei den Pflanzen der temperierten Zonen.

**373. Karyologische und genetische Studien an *Fragaria*. Ein tetraploider fertiler Bastard zwischen *F. nipponica* ( $n = 7$ ) und *F. elatior* ( $n = 21$ ). F. A. LILIENTHAL.** (Japan. Jour. Bot. **6**, 1933, 425-458, 37 Textabb.).

**374. Phytogeographical position of Japan concerning indigenous genera of vascular cryptogamic plants.** Genkei MASAMUNE. (Japan. Jour. Bot. **6**, 1933, 307-314).

**375. Studies on the elongation of petioles in some dicotyledons.** Takuma MASUDA. (Bot. Mag. Tôkyô **47**, 1933, 347-369, with tables and graphs).

If we divide, as it is usual in such experiments as mentioned in this paper, the young growing petiole into a certain number of zones of equal length, we see that the upper zones (most generally) (b-type) or the lower (a-type) most conspicuously elongate, while in another case each zone elongates almost equally (c-type). In the two former types the meristematic part has a great influence over the elongation process, while in a-type its important influence is not discernible. The energy of elongation is least in the lower zones in each type. In a full-grown petiole, if for example the uppermost zone shows the maximum elongation at a certain time, it is not the case throughout the whole growing period, inasmuch as other zones may show the maximum elongation at other times.

**376. Zur Kritik der Kryptogomerietheorie von BLEIER.** Kenzo MATSUMOTO. (Mem. Coll. Agric. Kyoto Imp. Univ. No. 25, 1933, 1-10, 18 Textabb.).

Nach der Kryptogomerie-Theorie BLEIERS sollen die elterlichen Kerne eines Bastardes individuell erhalten bleiben bis zur Zeit der Reduktionsteilung, worauf sie erst auseinander trennen. Die Beobachtungen BLEIERS beziehen sich auf einem Weizen×Roggen Bastard und einer Reihe von *Aegilops*×Weizenbastarden.

Auf Grunde der Beobachtungen über *Triticum vulgare*×*Secale cereale* und besonders *Aegilops ventricosa*×*Triticum durum* kommt der Verf. die Theorie BLEIERS zu verneinen. Nach den Beobachtungen Verfs. am letzteren Bastarde sieht man häufig eine eigentümliche Krümmung bzw. Knickung der Spindel und der ganze bietet den Anschein, als ob wir zwei getrennte Spindeln oder eine Doppelspindel mit einem gemeinsamen dritten Pol vor uns hätten. BLEIER hat den Fehler gemacht, um diesen Anschein für die Wirklichkeit anzunehmen, und folglich die Stelle der Spindel, wobei die Biegung oder Knickung am stärksten ist, als den oben angedeuteten gemeinsamen dritten Pol gedeutet, welche wirklich nichts anderes ist als der Aequator. Weiter nach BLEIER sollen die Chromosomenzahlenverhältnisse von beiden Spindeln beim Bastarde meistens gleichartig sein wie bei beiden Eltern, was nach dem Verf. keineswegs der Fall ist.

**377. A bibliographical monograph on plant genetics (Genic analysis). 1900-1929.** Second edition. Hajime MATSUURA. Sapporo, 1933, 780 pp.

The second edition of the book which appeared first in 1929. The arrangement of subjects remains the same as in the first edition, but the number of pages has considerably increased (i. e. from 499 to 786) on account of the enlargement and revision.

**378. On the pleistocene flora in prov. Yamashiro.** (Japanese). Shigeru MIKI. (Rpt. on the Study of Natural Monuments in Kyôto 14, 1933, 27 pp. and 5 pls.).

Fossil plants belonging to 13 families, 21 genera and 23 species obtained from the pleistocene layer in the Yamashiro basin were determined by the author. The following extinct species were found. viz. *Fagus microcarpa*, *Paliurus nipponicus*, *Trapa macropoda*, and some others which are considered to be new. The fossil plants obtained by the author may be classified according to their habits into seaside-, freshwater-, humid terrain-, and mountain plants. In the lowest stratum we may recognize the remains of marine plants, while in the uppermost the fresh water fossil plants



are abundantly preserved. It is probable that the climate at that time was similar to that of the present age, but a little warmer.

**379. On the regeneration of leaves and roots of some water and marsh plants in Japan.** (Japanese with English résumé). Shigeru MIKI. (Trans. Tottori Soc. Agric. Sc. **4**, 1933, 183-194, 8 text-figs.).

A certain number of water and marsh plants indigenous to Japan were studied in respect to their ability of regeneration. In the following plants regenerative buds were observed on cut leaves, except in the last two, where they were seen on cut roots, viz. *Trapella sinensis*, *Limnanthemum cristatum*, *L. indicum*, *Lindernia angustifolia*, *L. pyxidaria*, *Torenia crustacea*, *Inula japonica*, and *Menyanthes trifoliata*.

In *Limnanthemum indicum* regenerative buds were found to arise from endodermal cells, in *Lindernia angustifolia* from epidermal cells, and in *L. pyxidaria* from either epi-, hypo- or endodermal cells.

**380. Hydrophile Pflanzen aus Insel Etorohu.** (Japanisch). Shigeru MIKI. (Zeit. über Land- und Wasserstudien) **3**, 1933, 10-15, 2 Figurengruppen).

Dem Verf. sind 20 Arten von hydrophilen Pflanzen zur Verfügung gestanden, welche zu 13 Familien gehören und welche aus Insel Etorohu in Südkurilen angekommen sind. Unter diesen sind 12 Arten die Wasserpflanzen, von denen 6 zu den Potamogetonaceen gehören. Die Hydrocharitaceen und Najadaceen, welche im Innenlande Japans fast überall verbreitet sind, sind nicht vertreten. Wenn man 20 oben angedeuteten Arten oekologisch betrachtet, sind einige davon gänzlich unters Wasser untergetaucht (z. B. *Myriophyllum spicatum*, viele *Potamogeton*-arten), während bei einigen anderen die Blätter über das Wasserniveau hervortreten und mit der atmosphärischen Luft in Kontakt sind (z. B. *Nuphar pumilum*). Weiter sind freischwimmende (z. B. *Ceratophyllum demersum*), Ufer- (z. B. *Eleocharis palustris*) oder Sumpfpflanzen (z. B. *Eriophorum Scheuchzeri*) zu unterscheiden. Zum Schlusse sind die charakteristischen Merkmale verschiedener von ihm untersuchten Wasserpflanzen einzeln erläutert.

**381. On the disjunctive plant distribution in the Pacific regions from the natural protection point of view.** Manabu MIYOSHI. (Bot. Mag. Tôkyô **47**, 1933, 85-88).

The study of disjunctive plant distribution is interesting not only from the view point of biogeography, but also from that of nature protection. Some of these habitats in Japan were already preserved as natural monuments by law. 5 examples are given.

**382. Interspecific hybridization in *Brassica*. V. The cytology of  $F_1$  hybrid of *B. carinata* and *B. alboglabra*.** Toshitaro MORINAGA. (Japan. Jour. Bot. **6**, 1933, 467-475, 1 pl. and 14 text-figs.).

**383. Chronological distribution of fossil *Aralia* and a new species from Japanese neogene.** (Japanese). Hikoji MORITA. (Bot. Mag. Tôkyô **47**, 1933, 93-101, 2 figs.).



Fossils belonging to the genus *Aralia* are known upwards lower cretaceous strata. The upper cretaceous period may be said to be the most flourishing time of *Aralia* and its allied plants. Such fossils were mostly found in North America. *Aralia Yabei* nov. sp. found near Kobe is the very first example of *Aralia* ever collected in Japan. Its diagnosis is given.

**384. Additional notes on the Japanese Saprolegniaceae.** Masaji NAGAI. (Bot. Mag. Tôkyô **47**, 1933, 136-137, 1 fig.).

In his last paper on the monograph of the Japanese Saprolegniaceae (cf. Japan. Jur. Bot. **6**, (45), No. 150) he identified a certain water-mould as *Thraustotheca clavata* only provisionally on account of the want of sexual organs. The author could find now this fungus in a ditch in his college farm, and made its culture, whereupon he could confirm his former identification. Its detailed description incl. that of sexual organs is given.

**385. Number and behaviour of chromosomes in the genus *Narcissus*.** Seijin NAGAO. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B **8**, 1932, 81-200, 242 text-figs.).

The author's studies which are chiefly concerned with certain species of garden varieties of *Narcissus* have shown the fact that so far as his observations on pollen mother-cells go, the cardinal number of their chromosomes is either 7 or 10. In the varieties belonging to the latter case the somatic cells are diploid (20), triploid (30) and heteroploid (21, 22, 31, 32). The wild variety *Narcissus Tazetta* var. *chinense* is a triploid, whose somatic number of chromosomes is 30. In the varieties having 7 as the cardinal number somatic cells have 21 chromosomes, and in the heterotypic division 7 trivalents are often seen, which is characteristic of autotriploid plants. Besides them there are some varieties, for example, as hypertriploid plant ( $7_{III}+1_{II}$ ), etc.

According to FERNANDES there are in *Narcissus* three kinds of cardinal number, viz. 5, 6, 7, but the author on the basis of his investigations expresses the view that the cardinal numbers are 6, 7 and 10 instead of 5, 6, 7, as thought by FERNANDES.

The results of measurement of size of epidermal cells in the scale leaves of bulb on one hand as well as pollen grains on the other and their respective nuclei have shown that there is a certain correlation between them respectively.

**386. An observation on the gametophyte of *Cheiropleuria bicuspis* var. *integrifolia*.** (With Japanese résumé). Takenoshin NAKAI. (Bot. Mag. Tôkyô **47**, 1933, 1-5, 63-64, 2 text-figs.).

The study on the sporophyte morphology of *Cheiropleuria bicuspis* va. *integrifolia* usually ranked among the Polypodiaceae has formerly led the author to deny its polypodaceous nature and to establish a new family Cheiropleuriaceae. The present study of its prothallia which were got recently has confirmed his view. The chief points which conclusively deny that it belongs to the Polypodiaceae are the formation of mycorrhiza which never takes place in them and the form of the neck-part of the archegonia which protrudes out straight as in Schizaeaceae or Hymenophyllaceae instead of being curved as in the Polypodiaceae.

**387. Notes on Japanese ferns.** (With Japanese résumé). Takenoshin NAKAI. (Bot. Mag. Tôkyô **47**, 1933, 151-186, 210-223, 1 pl.)

According to Dr. HAYATA's publication in 1921 the number of the Japanese species belonging to the genus *Aspidium* is 21, incl. some BAKER's *Nephrodium*. These so-called *Aspidium* species are however very heterogeneous in respect to various characters, so, for instance, presence or absence of indusium, situation of sori, etc., and the author comes to the conclusion that they should be rightly placed among six genera, viz. *Aspidium*, *Dictyocline*, *Dictyopteris*, *Dryomenis*, *Pleocnemia* and *Sagenia*. The conspectus of these six genera is given in a tabular form, and all species belonging to each of them are enumerated.

**388. Nuntia ad plantas japoniae et koreae XLIII.** (With Japanese résumé). Takenoshin NAKAI. (Bot. Mag. Tôkyô **47**, 1933, 235-267, 313-320).

This enumeration of plants contains No. 1156-1187. Besides new varieties and combinations the following are new species: *Sanguisorba argutidens*, *Actinidia Lecomtei*, *A. Gagnepaini*, *Chrysophyllum Augustinii*, *Scopolia parviflora*, *Prunus velutipes*, *P. Mochidzukiana*.

**389. Experimente über die Keimung und Bewahrung der Samen von *Thujopsis dolabrata*.** (Japanisch). Yôzô NAKAJIMA. Verlag von Waldinspektion Bureau, Aomoriken, 1933, 26 S. m. 20 Tabellen).

Die Samenkeimung von *Thujopsis dolabrata*, welche sehr unregelmässig stattfindet, dauert sehr lange. Um diesen Vorgang zu beschleunigen machte der Verf. eine Anzahl von Versuchen, von denen einige ganz erfolglos waren. Es scheint, dass das Eintauchen der Samen im Wasser während bestimmter Zeit ihre Keimung etwas beschleunigt. Wenn auch der Verf. verschiedene Substanzen als das Keimungsbett gebraucht hat, hat er dabei keine besonders gute finden können. Dank der sog. Schichtungsmethode, wobei die Samen und die Flusssandschicht wechselweise in einen grossen Topf gelagert werden (im ganzen je 10 Schichte) und die Töpfe im Freien gelassen werden, konnte der Verf. eine beträchtliche Zunahme der Keimungsgeschwindigkeit sowie -prozent erzielen.

Bezüglich der Bewahrung der Samen sind dieselben, welche wegen der Absorption der Luftfeuchtigkeit an Gewicht zugenommen haben, schlecht keimungsfähig, während dieselben, welche mehr als lufttrocken sind, die guten Resultate gegeben haben. Dieselben, welche unter der Wirkung konz.  $H_2SO_4$  und Rohkalkes stark getrocknet sind, sind noch teilweise keimfähig. Die Samen, welche unter dem Einfluss von Adosol oder Reisstrohasche aufbewahrt wurden, und besonders dieselben der letzteren Kategorie, wenn unter der Kälte behalten, gaben die besten Resultate.

**390. Effects of low temperature on the germination of pollen grains and seeds.** (Japanese). Sadao NAKATOMI. (Proc. Crop Sc. Soc. Japan **5**, 1933, 91-101, 2 pls.).

When pollen-grains of certain plants (*Arachis*, *Nicotiana*, *Petunia*) are cooled for a few minutes (e. g. *Arachis* 1-3 min. at  $-10^{\circ}C$ , *Nicotiana*  $\pm 5$  min. at  $0^{\circ}$ , 3-5 min. at  $-5^{\circ}$  or  $-10^{\circ}$ , *Petunia* 1-3 min. at  $-5^{\circ}$  or  $-10^{\circ}$ ) their germination is accelerated, though the longer exposure to cool temperature retards it. By cooling seeds of certain cotton species for a few days the author could also accelerate their germina-

tion, thus for instance 10 days at  $-15^{\circ}$  for one strain, though the same treatment retards it in another.

**391. On the mechanism of the fatuoid and speltoid mutation.** (Japanese with English résumé). Ichizo NISHIYAMA. (Kwagaku (Science) 3, 1933, 147-152).

The résumé of the paper concerning the karyological studies of fatuoid and speltoid mutants of *Avena sativa* is as follows in the author's own words.

From cytological and genetical observations, fatuoid may be grouped into two groups: i. e., one (HUSKINS' A series) has arisen through complex gene mutation and the other by chromosome aberration. The latter includes 3 different types, a, b and c type. Heterozygous fatuoids from the a type (HUSKINS' B series) and from the b type have the same chromosome number,  $41 = 2n - c$ , but they show different genetic behaviors with each other. The c type (HUSKINS' C series) has been produced by loss of a part,  $s_2$ , of the c-chromosome which consists of  $s_1$  and  $s_2$ . Heterozygous fatuoids from this type, therefore, have  $20_{II} +$  a heteromorphic pair of chromosomes,  $cs_1$ .

Cytological studies on speltoids were attempted by some investigators, but their observations were not in good agreement. Reviewing these results, however, mechanisms of the occurrence of speltoids seem generally to be analogous to those of fatuoids stated just above.

HAKANSSON (1930) made a highly important observation on the C-series speltoid. In the heterozygous speltoid, he always found a heteromorphic pair of chromosomes, although he mentioned it as a trivalent, besides 20 normal bivalents. He also counted 42 chromosomes ( $2n$ ) or 21 bivalents in some homozygous speltoids from this series. On the basis of HUSKINS' chromosome formulas, it has to be expected that these homozygous fatuoids possess 44 chromosomes. From these results it is assumed more probable that the C-series speltoids may have the same chromosome condition as that of the c type fatuoid in the II-series.

**392. The genetics and cytology of certain cereals IV. Further studies of fatuoid oats.** Ichizo NISHIYAMA. (Japan. Jour. Gen. 8, 1933, 107-124, 2 pls. and 16 text-figs.).

The author distinguishes two series of fatuoid mutants of oat, of which the first has arisen from the cultivated oat through the mutation of a gene complex, and the second through a certain chromosome aberration. The present paper refers exclusively to the latter case. Heterozygous fatuoids of the type b of the second series. i. e. with  $20_{II} + c$  (cf. No. 391) shows a great variation in fertility in different years or under different conditions, and the segregation ratio varies considerably in correlation to their difference in fertility. The number of dwarf homozygous fatuoids (40 chromosomes,  $2n-2c$ ) increases with the increase of fertility, while heterozygous ones ( $20_{II} + c$ ) are less frequently seen. The number of normal plants ( $20_{II} + cc.$ ) shows always the variation within a very narrow limit, quite independently of the grade of fertility. Besides the three above mentioned a few aberrant plants are sometimes segregated out, thus for instance homozygous fatuoids  $20_{II} + s_2$ , and  $20_{II} + s_1 s_2$ , which are dwarf and highly sterile. It is to be added that the c-chromosome is composed of two arms of unequal length,  $s_1$  and  $s_2$ .



**393. Contributions to the knowledge of the sap stain of wood in Japan. I. Studies on *Ceratostemella ips* RUMBOLD, the cause of a blue stain of pine trees in Western Japan.** Yosikazu NISIKADO and Kiyû YAMAUTI. (Ber. Ôhara Ins. landw. Forsch. **5**, 1933, 501-538, 12 pls.).

The sap stain is due to the attack of a fungus which damages the sap wood of *Pinus densiflora* and *Thunbergii*. The cross-section of the wood attacked by this fungus is characterized by showing a number of black lines running along medullary rays from the cortex towards the heart wood, which become gradually narrower from the former towards the latter. The fungus is identified as *Ceratostemella ips* RUMBOLD. The hyphae run radially through parenchymatous cells of medullary rays from the cortex towards the heart wood, and their branches penetrate the resin-ducts as well as the tracheids. They run both transversally and longitudinally. Conidia are chiefly in the form of *Cephalosporium*-like clusters. The spherical perithecia are longly beaked with cylindrical ascospores. The culture of the fungus was done. Minimum temperature for mycelial growth 6-8°, optimum 27-29°, maximum 35°, optimum for conidia formation 27-31°, and that for perithecia formation 27-29°. 52° during 10 min. leads to death. Free access of oxygen is necessary for the conidia germination as well as mycelial growth.

**394. Zur Kenntnis der physiologischen Differenzierung der *Fusarium*-arten. I. Über den Unterschied der Pathogenität zwischen verschiedenen Stämmen des Bakanaepilzes von Reis.** (Japanisch). Yosikazu NISIKADO, Hiroyoshi MATSUMOTO und Kiyû YAMAUTI. (Nôgaku Kenkyû (Landw. Studien) **20**, 1933, 320-345).

66 Stämme vom Bakanaepilz von Reis, *Fusarium moniliforme* sowie *F. m. var. majus* sind für die Untersuchung genommen. Die Infektion wurde an Mais gemacht, da nach der Erfahrung der Verff. der Effekt der Infektion viel klarer tritt an Mais als an Reis. Die Verff. haben bei ihren Experimenten nachgewiesen, dass die Intensität der Überverlängerung der Maissämlinge nach verschiedenen Pilzstämmen verschieden ist.

**395. Zur Kenntnis der physiologischen Differenzierung der *Fusarium*-arten. II. Entwicklung verschiedener Stämme des Bakanaepilzes und Temperatur.** (Japanisch). Yosikazu NISIKADO, Hiroyoshi MATSUMOTO, und Kiyû YAMAUTI. (Nôgyô Kenkyû (Landw. Studien) **20**, 1933, 346-375).

Bei verschiedenen Bakanaepilzstämmen beträgt die Optimum-Temperatur für die Myzelentwicklung fast immer 27°, während bei *Fusarium moniliforme* und ihrer Varietät *majus* sie etwas höher beträgt, nämlich 29°. Der Stamm Nr. 649 kann ziemlich üppig entwickeln sogar bei 35°, während bei der überwiegenden Mehrzahl das Maximum und das Minimum 31-36° bzw. 7-8° beträgt. Der Umriss von Pilzrasen ist kreisförmig, und kann mehr oder minder scharf begrenzt sein, und zwar im allgemeinen bei höherer Temperatur sehr sehr scharf und bei niedriger unklar.

Viele Bakanaepilze verursachen die rote oder violette Färbung des gekochten Reises. Der Stamm Nr. 488 färbt ihn gelb, und es ist noch zweifelhaft, ob dieser Stamm ein Bakanaepilz ist.



**396. Mikrochemische Untersuchungen an über 1,800 Jahre lange aufbewahrten Holz—ein Beitrag zur Kohlenentstehungstheorie.** Kametaro OHARA. (Japan. Jour. Bot. **6**, 1933, 393-409, 2 Taf. und 5 Textfig.).

**397. Symbolae ad florae Asiae orientalis 7-8.** (With Japanese résumé). Jisaburo OHWI. (Acta phytotax. et geobot. **2**, 1933, 25-36, 102-108).

The following new species are described among others: *Saxifraga reniformis*, *Carex collifera*, *C. kurilensis*, *C. Hashimotoi*, *C. nachiana*, *Eleocharis Satoi*, *E. valleculosa*, *E. Tsurumachii*, *Bromus yezoensis*, *Poa shinanoana*, *Puccinellia sachalinensis*, *Trisetum koidzumianum*, *Juncus oligocephalus*, *Chrysosplenium Doianum*, *C. kiotoense*, *Mertensia pterocarpa*, *Meehania montis-koyae*.

**398. Physiological studies on *Drosera*. IV. On the function of microorganisms in the digestion of insect bodies by insectivorous plants.** Kunio OKAHARA. (Sc. Rts., Tôhoku Imp. Univ. 4th Ser. **8**, 1933, 151-168).

S. Japan. Jour. Bot. **6**, (48), No. 166.

**399. On the algae from Alaska collected by Y. KOBAYASHI.** Kintarô OKAMURA. (Rec. Oceanogr. Works Japan **5**, 1933, 85-97, 2 pls.).

37 species in all, belonging to green, brown as well as red algae are enumerated, of which two are new, viz. *Plenosporium kobayashii* spec. nov. and *Rhodymenia palmata* f. *grandifolia* f.n. A table indicating the distribution of all species mentioned in the main island of Japan, Hokkaidô, Saghalien, Kuriles, Alaska, Washington, California and Atlantic is appended.

**400. Life-history of *Coccophora Langsdorffii* (TURN.) GREV. K. OKAMURA and K. ÔSHIMA.** (Bot. Mag. Tôkyô **47**, 1933, 187-194, 10 text-figs.).

*Coccophora Langsdorffii* begins to grow out from the spores in May or June of the first year of its development. In September it develops to a seedling which in the spring of the second year grows up to the so-called *Phyllamphora*-form—*Coccophora Phyllamphora* of certain ancient authors producing dormant buds in the axil of both primary scaly as well as filiform leaves. During summer the vegetative frond attains its maximum growth, and during winter the bud grows up to a lateral shoot on which in the spring of the third year receptacles are produced; the frond decays before the summer of that year. So far as to the mode of development. The paper ends with some discussion on the systematic relationship with *Sargassum*.

**401. Über den Gaswechsel des Pollens von *Lilium auratum*, LINDL.** (Bot. Mag. Tôkyô **47**, 1933, 45-62).

Der Einfluss von KCN, CO, Methylenblau und Phenylurethan auf die Sauerstoffaufnahme des Pollens von *Lilium auratum*, LINDL. wurde manometrisch eingehenderweise untersucht. Sowohl KCN bez. CO wie auch Phenylurethan hemmen die O<sub>2</sub>-Aufnahme des Pollens nur in geringem Grade. So ist es hierbei anzunehmen, dass der grössere Teil der O<sub>2</sub>-Aufnahme desselben Pollens vom Vorhandensein des irgend eines anderen Systems als des sogenannten Atmungsfermentssystems und des Dehydrasesystems bedingt ist. Obwohl die O<sub>2</sub>-Aufnahme durch den Zusatz der

Atmungsgifte kaum gehemmt wird, nimmt die  $\text{CO}_2$ -Abgabe dabei in bedeutendem Masse zu, d.h. wird der Respirationsquotient grösser. Diese vermehrte  $\text{CO}_2$ -Abgabe rührt hauptsächlich von der anoxybiontischen Spaltung her. Solche Ergebnisse weisen auf die Tatsache hin, dass doch die  $\text{O}_2$ -Aufnahme mittels der KCN- bez. CO-hemmenden Farbstoffe wie Cytochrom in der  $\text{O}_2$ -Atmung desselben Pollens beteiligt ist, was aber in diesem Falle nicht so bedeutungsvoll erscheint, zumal da die Zunahme des Respirationsquotienten um so kleiner wird, je länger der Versuch dauert. Verf.

**402. Über den Gaswechsel des Pollens von *Thea sinensis*, L.** Kazuo OKUNUKI (Bot. Mag. Tôkyô. 47, 1933, 300-312).

Gleicherweise wie bei den Pollen von *Lilium auratum* wurde der Einfluss von KCN, CO, Methylenblau und Phenylurethan auf die Sauerstoffaufnahme des Pollens von *Thea sinensis*, L. bei 15°C. untersucht. Die Sauerstoffaufnahme dieses Pollens in destilliertem Wasser wird durch M/500-M/1000 KCN bei der Grundatmung ungefähr 30% und bei der Glucoseatmung ca. 50% gehemmt. Sie wird auch durch M/100-M/1000 Phosphat-Zusatz ziemlich stark gehemmt. Lässt man aber KCN mit Phosphatpuffer auf die Pollen einwirken, so zeigt deren Atmung eine fast vollständige Erholung von der Phosphat-Hemmung. Beim Zusammenwirken von M/250 Phenylurethan und M/1000 KCN bleibt die Grundatmung noch zu 32%, aber die Glucoseatmung nur zu 17% bestehen. Der Respirationsquotient ist 1.0, aber steigt beim Zusatz von KCN oder CO auf 1.3-1.5 an. Verf.

**403. Chromosom of *Rumex hastata*.** (Japanese). Tomowo ONO. (Bot. Mag, Tôkyô, 47, 1933, 558, 4 figs.).

*Rumex hastata* which was sent from Agra, India, shows in its pollen mother-cells 9 gemini in heterotypic metaphase and 9+9 chromosomes in anaphase. Each geminus looks apparently like a triploid chromosome of *Rumex acetosa*.

**404. Beobachtungen über japanische Moosflora IV. Laubmoose auf Insel Yakushima.** K. SAKURAI (Bot. Mag. Tôkyô 47, 1933, 331-346).

79 Arten, welche zu 28 Gattungen gehören, sind hervorgehoben, von denen 23 neu sind.

**405. On the action of sodium glycocholate on nuclei and chromosomes.** Michio SHIGENAKA. (Mem. Coll. Sc., Kyoto Imp. Univ. 8, 1933, 217-231, 3 pls.).

When the pollen mother-cells of *Tradescantia reflexa* and the root-tip cells of *Vicia Faba* are treated with a few drops of sodium glycocholate solution (1-2% generally) nuclei and chromosomes swell up so considerably that they finally wholly disappear, the matrix at first and then the spiral part. This action is accelerated by adding some neutral salts, as NaCl, KCl, etc., and then we observe under dark illumination a cloudy or turbid appearance after a certain lapse of time, the duration of which is variable according to the concentration of the sodium glycocholate solution. The intensity of turbidity depends on the concentration of salts added.

**406. Size of the cells of "bakanae"-seedlings.** (Japanese with English résumé). Shoichi SHIMADA. (Jour. Sapporo Soc. Agric. and Forest. 24, 1932, 169-178).

The author has made some observations to decide, whether the over-elongation of host plants caused by *Gibberella Fujikuroi*, the causal fungus of the bakanae disease of rice-plants, is due to the increase of the cell number or to the elongation of individual cells. He found that the "Langzelle" of epidermis and the mesophyll cells are longer in diseased than in healthy plants, and that the number of mesophyll cells per definite length of leaves is smaller in the former than in the latter. Further the author could not find any clear difference in the size and distribution of stomata between diseased and healthy plants.

**407. Change of pathogenicity shown by the "bakanae" fungus, *Gibberella Fujikuroi*.** (With Japanese résumé). Shoichi SHIMADA. (Trans. Sapporo Nat. Hist. Soc. **13**, 1933, 6-8).

*Gibberella Fujikuroi*, the causal fungus of the bakanae disease in rice plants which is characterized by causing the over-elongation of host plants was cultivated continuously in artificial media for long time. According to the results of the author's experiments such fungi have lost the power of causing the over-elongation, and besides the filtrate from nutrient solutions where they were cultivated contain no substances which accelerate the growth of host plants.

**408. A histochemical study of plant nuclei in rest and mitosis.** Namio SHINKE and Michio SHIGENAGA. (Cytologia **4**, 1933, 189-221, 9 text-figs.).

The authors have studied on the nuclear reticulum and chromosome the reactions of thymusnucleic acid, lipoids and proteins, the first chiefly according to the FEULGEN's schedule. The reactions were always positive. The chromosomes contain the thymusnucleic acid exclusively in the spiral part, and are more easily dissolved by lipid and nucleoproteid solvents than the resting nucleus, the matrix is far less resistant than the spiral part against the action. It is very probable that certain material changes will take place in the nuclear contents during mitosis. It is especially to be mentioned that the nucleus of *Spirogyra* shows the protein, but no thymusnucleic acid reaction. The karyolymph shows no positive reaction of thymusnucleic acid, lipid and protein, though probably lipoids may be present. The nucleolus contains lipoids, but no thymusnucleic acid, while the spindle-fibres and the phragmoplasts seem to consist of protein and lipid.

**409. Beitrag zur Kenntnis der Flagellaten aus Mukden, Mandschurei.** (Mit japan. Zfg.). B. W. SKVORTZOW. (Jour. Oriental Med. **16**, 1932, 3+(1) pp., 11 Textfig.).

12 Flagellaten sind enumeriert, von denen *Trachelomonas Fukudae* neu ist.

**410. Conspectus caricum florulae simotukensis.** (Japanese). Tiharu SUTÔ. (Jour. Agric. Studies Utunomiya) **8**, 1933, 24 pp.).

The paper which includes 102 species, 12 varieties and 3 forma of the genus *Carex* consists chiefly of an extensive analytical key for their identification. In the foot-note are given the Latin diagnoses of a number of species, varieties, new combinations. The following are new species: *C. aequibilibrostris* SUTÔ et SUZUKI and *C. kinugawaensis* SUTÔ et SUZUKI.



**411. Symbolae pteridographiae Asiae orientalis. IV.** (With Japanese résumé). Motozi TAGAWA. (Acta phytotax. et geobot. **2**, 1933, 14-24).

The following new species are described among others: *Athyrium pinetorum*, *A. silvicola*, *A. taiwanense*, *A. Tashiroi*, *A. kirishimaense*. New varieties and new combinations are also contained in this paper.

**412. Chromosome morphology in *Smilacina japonica*.** Masato TAHARA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. **8**, 1933, 33-37, 8 text-figs.).

The haploid chromosome number of *Smilacina japonica*, as studied in its pollen mother-cells, is 18. Of these 8 are much larger than the others, and situated generally in the periphery of the nuclear plate; they may be easily distinguishable in the anaphase of the first and second division. The diploid nuclear mitosis was studied in root-tip cells. The tetraploid nucleus was often observed in the latter.

**413. Further reports of the cytological investigations on the sterile plants.** (Japanese with English résumé). Yo TAKENAKA. (Jour. Chosen Nat. Hist. Soc. **13**, 1932, 2 pp. and 3 text-figs.).

In *Zingiber Mioga* and *Z. officinalis* the somatic chromosome number is 55 and 23 respectively. In the former the chromosome behaviour during the reduction division is very irregular in the heterotypic metaphase; the chromosome number is more than 11, and the pentavalents are always present. The author's conclusions are that *Z. Mioga* is an autopentaploid plant with the basic number 11, and its sterility is due to the irregular distribution of chromosomes during division.

**414. On the irregular meiotic division in the pollen mother-cells of *Lilium tigrinum*, KER-GAWL.** Yo TAKENAKA. (Bot. Mag. Tôkyo **47**, 1933, 125-131, 1 pl. and 1 group of text-figs.).

In the pollen mother-cells of *Lilium tigrinum* we see in the metaphase of the heterotypic division the univalents, bivalents and trivalents on the equatorial plane, the number of these three being in most cases 1, 1, and 11 respectively. The author could count 36 chromosomes in *L. tigrinum*, and he thinks that we are here dealing with an autotriploid plant with the basic number 12 ( $2n = 24$ ). Some discussions terminate the paper.

**415. Investigations on the relation between plants and their surrounding conditions by the quantitative method. V. Measurement of dimension of leaf intercellular spaces on several species of plants and its ecological significance.-IV. Variation of wayviness in the lateral walls of epidermal cells of leaves of *Taraxacum albidum* DAHLST. as related to meteorological conditions and its practical value as a phytometer.** (Japanese with English résumé). Makoto TAKE-NOUCHI. (Bult. Sc. Fak. Terk., Kjušu Imp. Univ. **5**, 1933, 254-263, 273-293).

Ad V. The author has measured the dimension of the intercellular spaces of leaves of various plants which are ecologically of different types. He could see, like others, that this dimension is greater in those of mesophytic than in those of evergreen or deciduous plants, and further in shady than in sunny leaves.



Ad VI. The root-cuttings from one and the same stock of *Taraxacum albidum* were planted in pots with the same kind of soil. These pots were placed (a) in Hukuoka City (2 m. above sea level), (b) half-way up Mt. Hikosan (650 m.) and (c) at the summit of the latter (1200 m.). It was found about the upper epidermal cells of leaves that the mean value of wavyness as determined by the formula  $m = L/L'$ , where  $m$  denotes the degree of waviness,  $L$  the actual length of lateral wall of a given epidermal cell, and  $L'$  that of the same considered as a circle, is greater in plants (c) than in those (a) and (b). The computation of the correlation coefficient between wavyness values and meteorological factors revealed the fact that such factors, as shadiness, humidity and rainfall are highly correlated with these values. The study of lower epidermis has not revealed such relation as above stated. The author thinks therefore that the upper epidermis is valuable as a phytometer for the meteorological factor in general.

**416. Über die Stoff- und die Energiebilanz bei dem Wachstumsvorgang des Schimmelpilzes. Bemerkungen zu der Arbeit von L. ALGERA.** Hiroshi TAMIYA. (Acta Phytochim., **7**, 1933, 27-41).

In einer früheren Arbeit [Acta Phytochim., **6**, 1932, 265.] hat der Verfasser gezeigt, dass bei der Kultur des Schimmelpilzes folgende Gleichung gültig ist:

$$G_{\Sigma C} = (M - M_0) \lambda_C + G_R, \quad (1)$$

worin

$G_{\Sigma C}$ : das Gewicht (in g) des insgesamt verbrauchten Zuckers,

$M$ : das Gewicht (in g) des Pilzkörpers am Versuchsende,

$M_0$ : das Anfangs-Pilzgewicht,

$\lambda_C$ : die Menge (in g) der Baustein-C-Quelle bei Bildung von  
1 g Pilzkörper,

$G_R$ : das Gewicht der veratmeten C-Quelle

bedeutet. Vom energetischen Standpunkt aus betrachtet lassen sich auch folgende Gleichungen aufstellen:

$$\mathfrak{U} = U_B + U_R \quad (2)$$

$$\mathfrak{U} = U_M + U_W \quad (3)$$

Hierbei bedeutet:

$\mathfrak{U}$ : die Energie des insgesamt verbrauchten Nährstoffs,

$U_B$ : die Energie des Bausteins,

$U_R$ : die durch Atmung freigesetzte Energie,

$U_M$ : die Energie des gebildeten Pilzkörpers,

$U_W$ : die insgesamt abgegebene Wärme.

Aus (2) und (3) folgt:

$$U_B - U_M = U_W - U_R \quad (4)$$

Die früheren Angaben von MOLLIARD und von TERROINE und WURMSER, dass  $U_B = U_M$  bzw.  $U_B < U_M$  sei, wurde bestritten, und zwar unter Hinweis auf die

Tatsache, dass die genannten Autoren bei Ermittlung der Werte von  $U_R$  bzw.  $U_B$  eine fehlerhafte Methode gebraucht haben. Die Voraussage vom Verfasser, dass  $U_B$  stets grösser als  $U_M$  sein soll, findet einen schönen Beweis in der neuen Arbeit von L. ALGERA [Rec. trav. botan. néerland., 29 (1932), 47] über die Stoff- und Energiebilanz bei der Kultur von *Aspergillus niger*.

Andererseits wurde aber gezeigt, dass die theoretischen Ausführungen von ALGERA in mehreren Hinsichten mangelhaft sind, und ferner, dass alle seine experimentellen Ergebnisse erst durch die aus der Theorie vom Verfasser abgeleiteten Formeln (1) bis (4) befriedigend erklärt werden können. Hingewiesen wurde noch darauf, dass das von ALGERA vorgeschlagene „Wachstumsrendement“  $\frac{U_M}{11 - U_R}$  keineswegs den echten Wirkungsgrad des Wachstumsvorgangs, sondern nur das Verhältnis  $\frac{U_M}{U_B}$  bedeutet.

Jedenfalls ist es sehr bemerkenswert, dass sich die von ALGERA und vom Verfasser fast gleichzeitig aus geführten Arbeiten experimentell und theoretisch so schön gegenseitig ergänzen. Verff.

**417. Über die Aufbau- und die Erhaltungsatmung. Beiträge zur Atmungsphysiologie der Schimmelpilze. III.** Hiroshi TAMIYA und Seizaburo YAMAGUCHI. (Acta Phytchim., 7, 1933, 43-64).

Diese Untersuchung schliesst sich an die frühere Arbeit von TAMIYA, und enthält eine Ergänzung und Erweiterung der damals entwickelten Theorie über die Energetik des Aufbau- und des Erhaltungstoffwechsels. Es wurde festgestellt, dass das Wachstum von einem Schimmelpilz *Aspergillus melleus* (auf zuckerhaltige Nährlösung), im Gegensatz zu der Annahme anderer Forscher, stets mit einer bestimmten Grösse der Sauerstoffatmung innig verknüpft ist. Die Sauerstoffatmung lässt sich nach ihrer Beziehung zu den zwei hauptsächlichsten Stoffwechselvorgängen der Zellen in „Aufbauatmung“ und „Erhaltungsatmung“ einteilen. Die auf Bildung von 1 g Pilzkörper bezogene Aufbauatmung nimmt mit dem Altern des Pilzes immer zu, während dabei die Erhaltungsatmung allmählich kleiner wird. Auf etwa 50-stündigem Kulturstadium werden etwa 40% der gesamten Sauerstoffatmung zum Aufbaustoffwechsel, und die übrigen 60% zum Erhaltungstoffwechsel zugewandt. Dieses Verhältnis nimmt mit dem Altern des Pilzes allmählich zugunsten der Erhaltungsatmung zu, bis schliesslich der Anteil der Aufbauatmung null wird. Entsprechend der Veränderung der Grösse der Aufbauatmung verändert sich auch der energetische Ausnutzungsgrad der Wachstumsvorgänge mit der Zeit. So beträgt er bei früheren Kulturstadien etwa 85%, nimmt aber mit dem Altern des Pilzes allmählich und zwar bis auf ungefähr 60% ab. Schliesslich haben die Verfasser darauf hingewiesen, dass die Wachstumsfähigkeit des Pilzes einen bedingenden Faktor für die Grösse der Aufbauatmung und der Erhaltungsatmung darstellt, und dass die Atmungsgrösse als ganzes in Bezug auf die Wachstumsgrösse durch eine Gleichung von zweiter Ordnung auszudrücken ist. Verff.

**418. The genetics and cytology on some varieties and hybrids of Japanese tobaccos.** (Japanese with English résumé). Hisajiro TANAKA. (Japan. Jour. Gen. S., 1933, 85-96, 5 pls.).

The author has studied the chromosomes in the pollen mother-cells of a number of varieties of tobacco-plants which were cultivated in Japan long since. The haploid number is generally 24, except in one variety called Ôkusaha where it varies from 24 to 48, etc. In *Nicotiana glauca* the haploid number is 12, as already mentioned by GOODSPEED. In *N. Tabacum* var. *petiolata* ( $n = 24$ )  $\times$  *N. glauca* ( $n = 12$ )  $F_1$  contains both uni- and bivalent chromosomes, the latter being in the number of 1-12. The allosyndesis seems to occur. This hybrid is self-sterile, and in  $F_1 \times N. glauca$  a few seeds were obtained, which however did not germinate.

**419. Studies on the physiology of the conidiophores, conidia and oospores of *Sclerospora graminicola* (SACC.) SCHROET. on the Japanese millet (*Setaria italica*) (L.) BEAUV.** (Japanese with English résumé). Heizi TASUGI. (Jour. Imp. Agric. Expt. Sta. 2, 1933, 225-262, 3 pls. and 6 text-figs.).

Though the formation of conidiophores and conidia may take place day and night under favourable external conditions, it takes place simply at night when weather is fine. Temperature for this process 18-20°C. The presence of a thin water layer over the leaf surface is also necessary for it. The conidiophores are small when the host plant is young, become gradually larger and then longest at the end stage of the host's growth. Their size is also dependent on the prevailing temperature, small under lower and large under higher, while under too high temperature no conidia formation will take place. Conidia also vary in their size according to the temperature. Their germination gives rise generally to swarmspores, optimum temperature 9-20,5°C. They will easily die under dryness. The germination of an oospore gives rise to a germ-tube, optimum temperature 20-23,5°C. Low H-ion concentration (for example 3.1) is best for the oospore germination, and free access of oxygen is necessary for this process. Oospores are pretty resistant against heat, and they will die under 50-55° only after several hours, but after 1½ hour under 60°. The degree of resistance against the following reagents was tried, viz. corrosive sublimate, formaldehyde, phenol, copper sulphate, lime-water, the first being most and the last least effective for control.

Almost no dormant period for the oospore germination is discernible. The oospores preserved under dry condition were observed to maintain their vitality during 1½ year.

**420. Alpine flora of Mt. Horonupuri, Kitami Ranges, Hokkaido, Japan.** Misao TATEWAKI. (Acta phytotax. et geobot. 2, 1933, 86-92).

62 plants are enumerated.

**421. Geschlechtsschrosomen bei einigen Lebermoosen I.** Seizi TATUNO. (Jour. Sc. Hiroshima Univ. Ser. B, Div. 2, 1, 1933, 166-182, 1 Taf. u. 70 Textabb.). (Auch in Bot. Mag. Tôkyô 47, 1933, 30-44, 56 Textabb.). (Japanisch mit deutsch. Zfg.).

Bei *Pallaviciana longispina* und *Calobryum rotundifolium* konnte der Verf. die Geschlechtsschrosomen beobachten, woher die Chromosomenformel für diese zwei Arten wie folgt sind:

	Gametophyt		Sporophyt
	♀	♂	
<i>Pallaviciana</i> . . . .	7+X	7+Y	14+X+Y
<i>Calobryum</i> . . . .	8+X	8+Y	16+X+Y

Die Heteropyknose wurde nachgewiesen.

Bei *Makinoa crispata* hat der Verf. keine Geschlechtschromosomen unterscheiden können.

Die Chromosomenformeln bei *Pellia Neesiana* und *P. Fabbroniana* sind nach LORBEER ♀ 7+X+Y, ♂ 7, und nach SHOWALTER und HEITZ ♀ 8+X, ♂ 8+Y; der Verf. konnte die Resultate der zwei letzteren Autoren bestätigen.

**422. Geschlechtschromosomen bei einigen Lebermoosen II.** Seizi TATUNO. (Japanisch m. deutsch. Zfg.). (Bot. Mag. Tôkyô **47**, 1933, 438-445, 33 Textabb.).

Der Verf. hat bei *Pallaviciana Lyelli* die Geschlechtschromosomen beobachtet, wobei ihre Chromosomenformel wie folgt steht:

	Gametophyt		Sporophyt
	♀	♂	
	7+X	7+Y	14+X+Y

Die Heteropyknose ist bemerkbar.

Weiter untersuchte der Verf. die Meiosis bei *P. Fabbroniana* (vgl. Nr. 421). Nach seinen Beobachtungen tritt das X-Y-Geminus bei der heterotypischen Metaphase auf die Kernplatte auf, worauf X und Y je nach beiden entgegengesetzten Polen übergehen, sodass der eine von beiden Tochterkernen X und der andre Y bekommt.

**423. Über die Fruchtgestalt der Bastarde zwischen *Brassica* und *Raphanus*.** (Japanisch). Yasufusa TERASAWA. (Japan. Jour. Gen. **8**, 1933, 105-115, 2 Textabb.).

Die Schote der *Brassica-Raphanus*-Bastarde ist aus klappigem und nicht klappigem Teile zusammengesetzt. Der Verf. hat die Länge dieser Teile an verschiedenen Bastardindividuen zwischen *Brassica chinensis* ( $2n = 20$ ) und *Raphanus sativus* ( $2n = 18$ ) vergleichend gemessen und die Tatsache festgestellt, dass das Längenverhältnis zwischen denselben mit den Chromosomenzahlen von beiden Eltern intensiv korreliert ist.

**424. Freezing of plants in late autumn and early winter.** (Japanese). Kogo TOGASHI. (Jour. Plant Prot. **20**, 1933, 32-39).

The temperature which prevailed during the author's observations was 1.1-4.6°C under zero. The degree of damage done by freezing of a number of plants of different types is shown in an extensive table. He distinguishes three types concerning the external aspect of freezing. Firstly, leaves hang down without losing their original colour, and do not generally recover their life (*Petunia*, *Dianthus*, *Helichrysum*); secondly, leaves become rolled up as if they were dried up (*Diervilla*, *Elaeagnus*, etc.); and thirdly, leaves become gradually yellow or brown without losing their original shape (*Asparagus*, *Aquilegia*, etc.).



**425. A contribution to the knowledge of parasitism of *Valsa Paulowniae*, in relation to temperature.** Kogo TOGASHI and Kanae UCHIMURA. (Japan. Jour. Bot. 6, 1933, 477-487, 4 text-figs.).

**426. On the organic iodine in *Laminaria ochotensis* MIYABE with especial reference to protein iodine, and search for diiodotyrosine.** Yoshiyuki TORYU. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. 8, 1933, 107-110).

In *Laminaria ochotensis* about 6% of total iodine is insoluble in alcohol, of which 5% is protein and 1% non-protein iodine. Diiodothyrosine may exist in the protein of this alga, though not isolated as crystals.

**427. On the reappearance of the haploid in the Japanese morning glory.** Nagaharu U. (Japan. Jour. Bot. 6, 1933, 225-243, 9 pls. and 9 text-figs.).

**428. Karyological studies in Japanese bamboos I. The chromosome number of several species.** Isamu UCHIKAWA. (Mem. Coll. Agric. Kyoto Imp. Univ. No. 25, 11-20, 19 figs.).

The chromosome number of several Japanese bamboos (6 species and varieties) belonging to the genera *Phyllostachys*, *Sinobambusa*, *Chimonobambusa* and *Pleioblastus* was determined,  $n$  in pollen mother-cells and  $2n$  in root-tip cells. It was  $n = 24$  and  $2n = 48$  in all plants examined. The meiotic divisions, both hetero- and homotypic, are quite regular.

**429. On the forest zone of Korea.** (Japanese). Homiki Uyeiki. (Acta phytotax. et geobot. 2, 1933, 73-85, 2 text-figs.).

The author first makes critical remarks on a number of the publications of various botanists which are concerned more or less extensively with the Korean flora, and then discusses the Korean geology and climatology. The forest zones (horizontal) are according to the author warm, temperate and cold; he enumerates some examples of plants from each zone. The vertical forest zones which are also divided into warm, temperate and cold are indicated concerning several mountains with certain plant examples from each.

**430. Mikrodisektion der Chromosomen von *Tradescantia reflexa*.** (Vorl. Mitt.). Bungo WADA. (Cytologia 4, 1933, 222-227, 1 Taf.).

Durch den Gebrauch der Mikronadeln konnte der Verf. an den Pollenmutterzellen von *Tradescantia reflexa* die folgenden Tatsache feststellen (in den eigenen Worten des Verfs.):

1. Durch das Auseinanderziehen einzelner Chromosomen der Pollenmutterzelle von *Tradescantia reflexa* mit den Mikronadeln lösen sich die Spiralen der Chromomata kontinuierlich auf und dehnen sich zu langen feinen Fäden aus.

2. Bei den angequollenen Pollenmutterzellen wird das Vorhandensein einzelner Chromosomen durch das Auseinanderziehen des optisch homogen aussehenden Chromosomenteils mit den Nadeln nachgewiesen.

3. Die Spiralstruktur der somatischen Chromosomen tritt erst durch das Auseinanderziehen derselben mit den Nadeln im Medium in Erscheinung.

**431. Über die Bedeutung der Nährhefen für die Entwicklung von Myxomyceten-Plasmodien.** Atsushi WATANABE. (Bot. Mag. Tôkyô, 47 (1933), 195-199).

Mit 14 Arten Myxomyceten und 14 Arten Hefen wurden vorliegende Untersuchungen angestellt und die relative Stärke der Vorliebe verschiedener Myxomyceten für die Nährhefen wurde zahlenmässig gezeigt. Dabei erwies sich *Saccharomyces ellipsoideus* als die beste Nahrung für alle untersuchte Myxomyceten. Unter den Myxomyceten zeigte *Didymium nigripes* FRIES var. *xanthopus* LISTER die beste Entwicklung nach Fütterung mit Hefen. Im Vergleich mit den ebenfalls verwendeten Bakterien, weisen die Hefen im allgemeinen eine grössere Nährwirkung für die Entwicklung der Myxomyceten-Plasmodien, obwohl dabei das Vermögen, die Sporangienbildung zu veranlassen, kleiner bleibt. Verf.

**432. Notes on some Japanese algae. V.** Yukio YAMADA. (Jour. Fac. Sc., Hokkaido Imp. Univ. Ser. V, 2, 1933, 277-285, 4 pls.).

The following new species are described with figures: *Bornetella ovalis*, *Caulocanthus Okamurai*, *Chrysomenia pacifica*, *Farlowia irregularis*, *Ptilonia Okadae*.

**433. Über den Einfluss einiger Gifte und der Temperatur auf den Ausnutzungsgrad der Atmungsenergie beim Wachstum des Schimmelpilzes.** Atsushi YAMAMOTO. (Acta Phytochimica 7, 1933, 65-92).

Zweck der vorliegenden Arbeit war die Feststellung der Einflüsse von einigen Giften (NaF, CO, Phenylurethan, KCN und Monojodacetat) und der Temperatur auf das Verhältnis:

$$\frac{(\text{Wachstumsgrösse})}{(\text{Atmungsgrösse})}$$

bei der Kultur eines Schimmelpilzes, *Aspergillus niger*. Dieser Koeffizient, den man Aufbauquotienten (AQ) nennt, stellt—wie neulich von TAMIYA hervorgehoben—einen einfachen, wenn auch etwas grosszügigen, Ausdruck des energetischen Ausnutzungsgrades beim Wachstumsvorgang, weil das Schimmelpilzwachstum nur unter Aufwand der Atmungsenergie verwirklicht werden kann.

Es stellte sich heraus, dass die untersuchten Giftstoffe sich nach ihrer Wirkungsweise in folgende drei Gruppen einteilen lassen:

(1) Die Giftstoffe, welche primär die Atmungsvorgänge und nur sekundär die Wachstumsfähigkeit affizieren, um dadurch die Vergrösserung des AQ-Wertes hervorzurufen. Hierher gehört das KCN.

(2) Die Giftstoffe, welche in erster Linie die Wachstumsvorgänge oder wahrscheinlicher die energetische Ausnutzung beim Aufbauvorgang stören, was also die Verkleinerung des AQ-Wertes mit sich führt. Dazu gesellen sich Phenylurethan, CO und NaF.

(3) Die Giftstoffe, welche die Atmung und das Wachstum praktisch um denselben Betrag herabsetzen, sodass dadurch der AQ-Wert im wesentlichen nicht modifiziert wird. Ein Beispiel von dieser Gruppe stellt Monojodacetat dar.

Alle diese Gifte sind aber darin einig, dass sie, sei es direkt oder indirekt, auf die absolute Grösse der Atmung sowie des Wachstums herabsetzend wirken. Was nun den Temperatureinfluss anbelangt, so wurde es nachgewiesen, dass die optimale



Temperatur für die Grösse von AQ bei 25° liegt, während diejenige für die Wachstums- bzw. die Atmungsgrösse selbst sogar höher als 35° ist. Diese Tatsache dürfte bei den niedrigeren Temperaturen als 25° wohl wegen der Verkleinerung der Geschwindigkeit des Aufbauvorgangs selbst, bei höheren Temperaturen aber wegen des Einsetzens der unnützlichen Oxydationsvorgängen hervorgerufen sein.

Gestützt auf solchen Ergebnissen kann man auch ohne weiteres auf die Beeinflussbarkeit der von PFEFFER sowie auch von RUBNER vorgeschlagenen Ausnutzungskoeffizienten des Wachstumsvorgangs durch die in Betracht kommenden Faktoren schliessen, weil solche Koeffizienten, wie von TAMIYA gezeigt, mit dem vom Verfasser angewandten AQ-Wert in einem einfachen proportionalen Verhältnis stehen.

**434. Species novae orchidacearum ex Insula Ponape (Micronesia).** (With Japanese résumé). Yoshimatsu YAMAMOTO. (Trans. Nat. Hist. Soc. Formosa **23**, 1933, 20-23, 2 figs.).

The two new species are described with the help of photographs: *Arundina Kanehirae* YAMAMOTO, *Vanilla ponapensis* KANEHIRA et YAMAMOTO.

**435. An autohexaploid plant of *Rumex acetosa* L.** (Japanese with English résumé). Yukio YAMAMOTO. (Japan. Jour. Gen. **8**, 1933, 125-130, 4 text-figs.).

The author has got a triploid intersexual plant of *Rumex acetosa* with the chromosomal formula  $2X+1Y_1+1Y_2+18a=22$ . Among its progenies an autohexaploid plant appeared, viz.  $4X+2Y_1+2Y_2+36a=44 (=6n)$ . Since the author could observe in the heterotypic metaphase of the triploid parent the nuclear plate with unreduced chromosome number and besides the restitution nuclei were observed he thinks that the autohexaploid plant just mentioned might be the result of the conjugation of ♂ and ♀ gametes with unreduced chromosome numbers.

**436. Identification of the sexes in dioecious plants by testing the resistance to the toxic action of chlorate.** Morimasa YAMASAKI. (Japan. Jour. Bot. **6**, 1933, 459-466, 4 text-figs.).

**437. Genetical studies in *Zea Mays* L.** (Japanese). Kono YASUI. (Bot. Mag. Tôkyô **47**, 1933, 138-145, 2 figs.; 203-209).

Genetical studies were made on some strains of *Zea Mays* which are indigenous to Japan, and especially on those cultivated in the Kôti-Prefecture. Among the results of the investigations will be given below only a few examples.

Dwarf strain, recessive to normal, and monogenic difference between them. Chromosome number is  $2n=20$  in both strains.

Yellow seedling which dies at a certain young stage of its development (lethal factor). The plant containing this factor may attain its full development simply as a heterozygote. The difference between normal and yellow is monogenic.

The crossing experiments between the plant with bluish purple grains (pigment in the aleurone layer) and that with white ones have shown that the segregation takes place either according to the schema 3 (purple) : 1 (white) or 9 (purple) : 7 (white), i.e. the difference between the two strains is either mono- or digenic.

Etc., etc,

**438. On the pathogenic organism of the leaf spot disease of *Gomphrena globosa*.** (Japanese with English résumé). Hajime YOSHII. (Ann. Phytopath. Soc. Japan 2, 1933, 513-519).

The causal fungus of the leaf spot disease of *Gomphrena globosa* seems to be morphologically identical to *Alternaria Gomphrenae* TOGASHI, though different in some respects.

**439. Studies in the cytology of Pteridophyta II. The morphology of spermatozoids of some ferns.** Akira YUASA. (Cytologia 4, 1933, 305-337, 2 pls., 48 text-figs. and 6 graphs).

The author has studied the structure of spermatozoids of seven species of ferns (one from each of the genera *Polypodium*, *Adiantum*, *Pteris*, *Leptogramme*, *Polystichum*, *Drymoglossum*, *Leptochilus*) in dried condition or after fixing. The structure is nearly the same in all though of course certain small differences are present. He could distinguish the following parts, viz. nucleus, cilia-bearing band, border-brim, lateral bar, cilia, and plasma fragment. Of these parts the border-brim is situated opposite to the nucleus lying in the anterior part of the spermatozoid body, and corresponds for example to "färbbarer Faden" of BELAJEFF, "Randleiste" of MÜHLDOERF, etc. The cilia-bearing band which is cytoplasmic in its nature is placed between the border-brim and the nucleus, and the cilia develop from one side of its surface. The middle line is found along the middle region of its surface. The border-brim was considered as the cilia-bearing part by BELAJEFF. What SHARP calls concerning *Equisetum* the blepharoplast which bears cilia corresponds to the border-brim of the author. He takes the cilia-bearing band for the cilia-bearing part, and not the border-brim.

He counted the number of cilia in the spermatozoid of each species examined by him, and shows its frequency in tables and graphs. To cite only one single example, in *Adiantum capillus-veneris* this number varies from 23 to 43, the mode being at 30.

Concerning other details cf. the original.